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A COMPARISON OF MEASURED DATA AND ITS MODEL PREDICTIONS.(U)
JAN 78 R D SMITH
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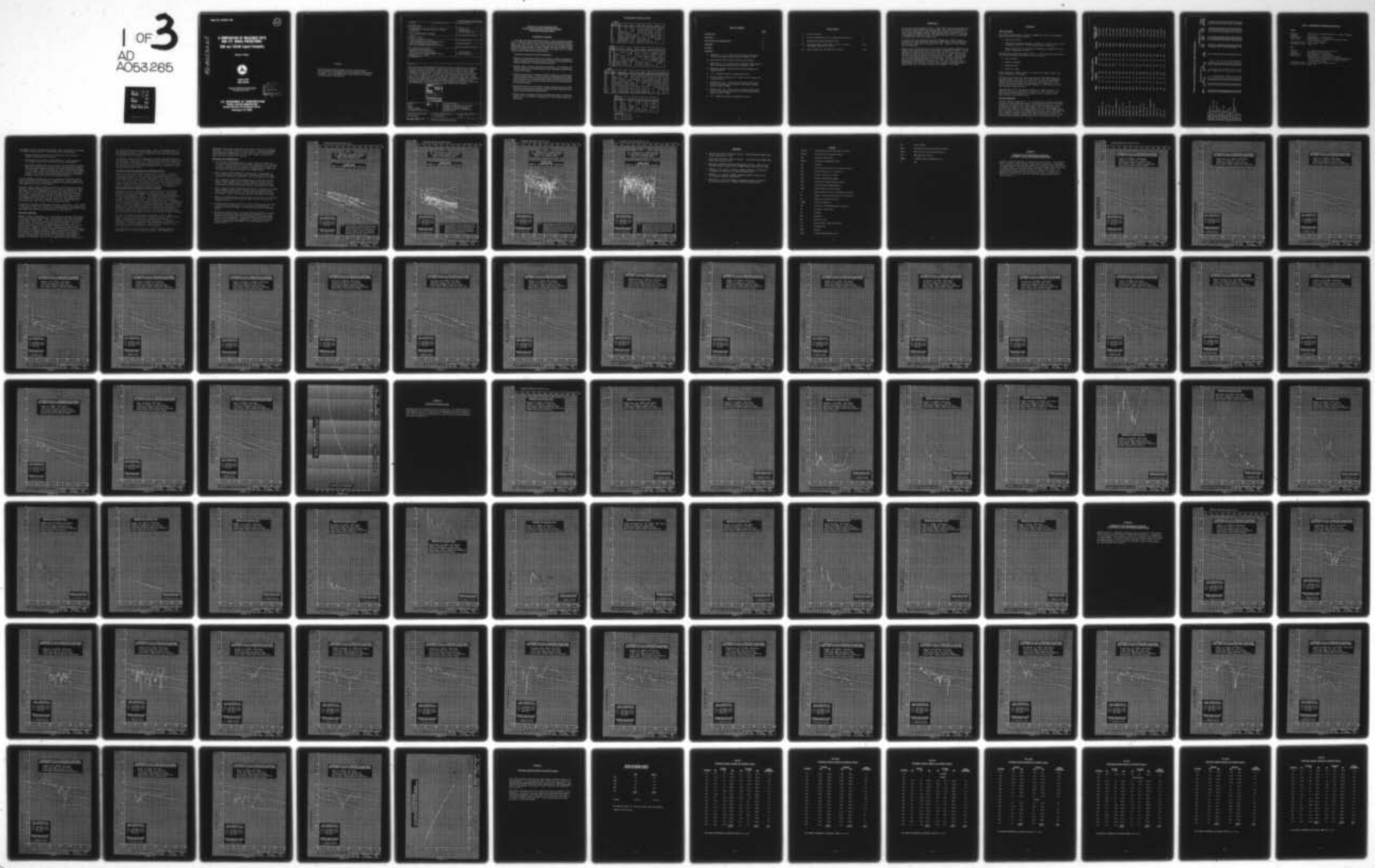

Report No. FAA-RD-77-106

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A COMPARISON OF MEASURED DATA AND ITS MODEL PREDICTIONS:

VOR and TACAN Signal Strengths

Robert D. Smith

January 1978

FINAL REPORT

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16. Abstract

The Institute of Telecommunication Sciences (ITS) has developed for the Federal Aviation Administration (FAA), a computer model (IF-77) which predicts signal strengths, desired-to-undesired signal ratios, and a variety of other radio propagation related outputs. The model is periodically updated as ITS improves its prediction capability. The model was last validated by FAA about 10 years ago. Since a number of changes have been made to the model since then, revalidation is not inappropriate. In this Report, propagation predictions are compared with VOR and TACAN signal strength measurements taken on 20 VORTAC's in the Southwest Region of the United States. This comparison confirms once again, that the ITS/FAA model accurately predicts VOR and TACAN signal strength.

17. Key Words
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FEDERAL AVIATION ADMINISTRATION
SYSTEMS RESEARCH AND DEVELOPMENT SERVICE
SPECTRUM MANAGEMENT STAFF

STATEMENT OF MISSION

The mission of the Spectrum Management Staff is to assist the Department of State, Office of Telecommunications Policy, and the Federal Communications Commission in assuring the FAA's and the nation's aviation interests with sufficient protected electromagnetic telecommunications resources throughout the world to provide for the safe conduct of aeronautical flight by fostering effective and efficient use of a natural resource--the electromagnetic radio-frequency spectrum.

This objective is achieved through the following services:

- Planning and defending the acquisition and retention of sufficient radio-frequency spectrum to support the aeronautical interests of the nation, at home and abroad, and spectrum standardization for the world's aviation community.

- Providing research, analysis, engineering, and evaluation in the development of spectrum related policy, planning, standards, criteria, measurement equipment, and measurement techniques.

- Conducting electromagnetic compatibility analyses to determine intra/inter-system viability and design parameters, to assure certification of adequate spectrum to support system operational use and projected growth patterns, to defend the aeronautical services spectrum from encroachment by others, and to provide for the efficient use of the aeronautical spectrum.

- Developing automated frequency-selection computer programs/routines to provide frequency planning, frequency assignment, and spectrum analysis capabilities in the spectrum supporting the National Airspace System.

- Providing spectrum management consultation, assistance, and guidance to all aviation interests, users, and providers of equipment and services, both national and international.

ENGLISH/METRIC CONVERSION FACTORS

LENGTH

From \ To	Cm	m	Km	in	ft	s mi	n mi
Cm	1	0.1	1×10^{-5}	0.3937	0.0328	6.21×10^{-6}	5.39×10^{-6}
m	100	1	0.001	39.37	3.281	0.0006	0.0005
Km	100,000	1000	1	39370	3281	0.6214	0.5395
in	2.540	0.0254	2.54×10^{-5}	1	0.0833	1.58×10^{-5}	1.37×10^{-5}
ft	30.48	0.3048	3.05×10^{-4}	12	1	1.89×10^{-4}	1.64×10^{-4}
S mi	160,900	1609	1.609	63360	5280	1	0.8688
n mi	185,200	1852	1.852	72930	6076	1.151	1

AREA

From \ To	Cm^2	M^2	Km^2	in^2	ft^2	S mi^2	n mi^2
Cm^2	1	0.0001	1×10^{-10}	0.1550	0.0011	3.86×10^{-11}	5.11×10^{-11}
m^2	10,000	1	1×10^{-6}	1550	10.76	3.86×10^{-7}	5.11×10^{-7}
Km^2	1×10^{10}	1×10^{6}	1	1.55×10^{9}	1.08×10^{7}	0.3861	0.2914
in^2	6.452	0.0006	6.45×10^{-10}	1	0.0069	2.49×10^{-10}	1.88×10^{-10}
ft^2	929.0	0.0929	9.29×10^{-8}	144	1	3.59×10^{-8}	2.71×10^{-8}
S mi^2	2.59×10^{10}	2.59×10^{6}	2.590	4.01×10^{9}	2.79×10^{7}	1	0.7548
n mi^2	3.43×10^{10}	3.43×10^{6}	3.432	5.31×10^{9}	3.70×10^{7}	1.325	1

VOLUME

From \ To	Cm^3	Liter	m^3	in^3	ft^3	yd^3	fl oz	fl pt	fl qt	gal
Cm^2	1	0.001	1×10^{-6}	0.0610	3.53×10^{-5}	1.31×10^{-6}	0.0338	0.0021	0.0010	0.0002
liter	1000	1	0.001	61.02	0.0353	0.0013	33.81	2.113	1.057	0.2642
m^2	1×10^{6}	1000	1	61,000	35.31	1.308	33,800	2113	1057	264.2
in^3	16.39	0.0163	1.64×10^{-5}	1	0,0006	2.14×10^{-5}	0.5541	0.0346	2113	0.0043
ft^3	28,300	28.32	0.0283	1728	1	0.0370	957.5	59.84	0.0173	7.481
yd^3	765,000	764.5	0.7646	46700	27	1	25900	1616	807.9	202.0
fl oz	29.57	0.2957	2.96×10^{-5}	1.805	0.0010	3.87×10^{-5}	1	0.0625	0.0312	0.0078
fl pt	473.2	0.4732	0.0005	28.88	0.0167	0.0006	16	1	0.5000	0.1250
fl qt	948.4	0.9463	0.0009	57.75	0.0334	0.0012	32	2	1	0.2500
gal	3785	3.785	0.0038	231.0	0.1337	0.0050	128	8	4	1

MASS

From \ To	g	Kg	oz	lb	ton
g	1	0.001	0.0353	0.0022	1.10×10^{-6}
Kg	1000	1	35.27	2.205	0.0011
oz	28.35	0.0283	1	0.0625	3.12×10^{-5}
lb	453.6	0.4536	16	1	0.0005
ton	907,000	907.2	32,000	2000	1

TEMPERATURE

$^{o}F = 5/9\ (^{o}C - 32)$

$^{o}C = 9/5\ (^{o}F) + 32$

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INTRODUCTION

In June 1975, AAF-400 requested that in flight signal strengths measurements of 20 Southwest Region VORTAC facilities be made. This effort was requested as input in the evaluation of VOR and TACAN radiated power requirements for the second generation VORTAC program. The Airway Facility Service was interested in determining if VOR carrier power and TACAN peak power could be established at 100 watts and 5000 watts respectively.

In October 1975, the measurement work was completed by personnel from the Oklahoma City Flight Inspection Field office (OKC FIFO). The resulting data was provided to AAF-400 and an analysis was done. Results of this analysis were not published.

Early in 1977, during discussion on the update of the National Standard on the VORTAC system, AAF-410 offered to provide this information to ARD-60. We have compared the measured data with the predictions of the ITS/FAA model (IF-77). The amount of measured data presented in this report is small in comparison with the data that was used in the development of the model. Just the same, with the developments foreseen in the near future, we felt it important to see how these measurements compare with the model. We would expect the measured and predicted data to compare well. If this is the case, then it makes sense to use the model rather than going through a large measurement program each time a decision is required for changes in the system.

DISCUSSION

DATA COLLECTION

The Flight Standard Service selected 20 VORTAC facilities in the Southwest Region under the following criteria:

a. Class H facilities

b. Anticipated acceptable coverage at 18,000 feet (5486 m) above the site elevation in excess of 110 nmi (204 Km) from the facility.

c. Usable distance is not restricted by shadowing of mountains or other objects (man made or natural).

The facilities selected are shown in Table 1. The Airway Facilities Service collected the following information for each facility:

a. Site elevation

b. Channel assignment

c. TACAN peak power

d. VOR carrier power

This information is shown in Table 2 along with the flight elevation and radial azimuth for each flight.

The flight measurements were made using a Convair 580 Flight Inspection Aircraft (N-92). One radial of each facility was flown at approximately 18000 feet (5486 m) above the site elevation. At ten facilities, both inbound and outbound flights were made between the distances of 110 nmi (204 Km) and 140 nmi (260 Km) from the facility. At the other ten sites, only outbound flights were made.

Characteristics of the measurement equipments are shown in Table 3. Of particular interest is the point of calibration. The location of this point dictates what adjustments are needed in order to reference the measured data to the antenna output.

VOR DATA COMPARISON

Appendix A shows a comparison of ITS predictions of available VOR signal in space and measured antenna output. The predictions were made for general variability, 4/3 smooth earth. The measured data was adjusted so that it represents the signal at the antenna output. Since the VOR calibration point was at the input to the signal splitter and not at the antenna output, It was necessary to add 0.5 dB (compensation for cable loss) to the measured data. Appendix A compares the predicted signal which would be available from a lossless isotropic antenna (this does not include the effect of the airborne antenna pattern) with measured data at the antenna output (this

TABLE 1, FACILITY LISTING

	IDENT	LATITUDE			LONGITUDE			ELEV MSL	FREQUENCY (MHz) CHANNEL No.
Abilene, Tx.	ABI	32	28	53N	99	51	47W	1810′	113.7/84X
Albuquerque, N.M.	ABQ	35	02	38N	106	48	57W	5740′	113.2/79X
Amarillo, Tx.	AMA	35	17	15N	101	38	20W	3550′	117.2/119X
Cimarron, N.M.	CIM	36	29	29N	104	52	17W	6550′	116.4/111X
El Paso, Tx.	ELP	31	48	57N	106	16	53W	4020′	115.2/99X
Greater Southwest, Tx.	GSW	32	49	10N	97	02	28W	545′	113.1/78X
Junction, Tx.	JCT	30	35	52N	99	49	02W	2280′	116.0/107X
Las Vegas, N. M.	LVS	35	39	27N	105	08	06W	6870′	117.3/120X
Millsap, Tx.	MQP	32	43	34N	97	59	49W	890′	117.7/124X
Oklahoma City, OK.	OKC	35	26	33N	97	46	21W	1393′	115.0/97X
Pioneer, OK.	PER	36	44	47N	97	09	35W	1059′	113.2/79X
Roswell, N.M.	ROW	33	20	15N	104	37	15W	3785′	116.1/108X
San Angelo, Tx.	SJT	31	22	29N	100	27	16W	1890′	115.1/98X
San Antonio, Tx.	SAT	29	38	38N	98	27	40W	1160′	116.8/115X
Texico, Tx.	TXO	34	29	42N	102	50	21W	4060′	112.2/59X
Truth or Consequences	TSC	33	16	57N	107	16	48W	4903′	112.7/74X
Tucumeari, N.M.	TCC	35	10	56N	103	35	53W	4070′	113.6/83X
Tulsa, OK.	TUL	36	11	46N	95	47	16W	790′	114.4/91X
Waco, Tx.	ACT	31	39	44N	97	16	07W	536′	115.3/100X
Wink, Tx.	INK	31	52	29N	103	14	35W	2870′	112.1/58X

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(9)

TABLE 2, FACILITY CHARACTERISTICS AND FLIGHT CHARACTERISTICS

	IDENT	TRANSMITTER POWERS VOR Watts	VOR dBw	TACAN KW	TACAN dBw	DATE Oct 75	ALTITUDE IN FEET SITE ELEV	FLIGHT LEVEL	ABOVE SITE	RADIAL AZIMUTH (MAGNETIC)
Abilene, Tx.	ABI	140	(21.5)	10.0	(40)	16	1810	19810	18000	210°
Albuquerque, N.M.	ABQ	125	(21)	4.6	(36.6)	15	5740	23740	18000	180°
Amarillo, Tx.	AMA	100	(20)	4.2	(36.2)	14	3550	21500	17950	100°
Cimarron, N.M. (Mt. Top)	CIM	140	(21.5)	10.0	(40)	15	6550	24550	18000	110°
El Paso, Tx.	ELP	145	(21.6)	10.0	(40)	16	4020	22000	17980	115°
Greater Southwest, Tx.	GSW	150	(21.8)	4.1	(36.1)	17	545	18580	18035	175°
Junction, Tx.	JCT	130	(21.1)	10.0	(40)	16	2280	20280	18000	150°
Las Vegas, N.M.	LVS	120	(20.8)	4.0	(36)	15	6870	24870	18000	90°
Millsap, Tx.	MQP	130	(21.1)	5.2	(37.2)	17	890	18890	18000	140°
Oklahoma City, OK.	OKC	140	(21.5)	5.0	(37)	17	1393	19360	17897	140°
Pioneer, OK.	PER	100	(20)	4.2	(36.2)	17	1059	19600	18541	170°
Roswell, N.M.	ROW	122	(20.9)	10.0	(40)	15	3785	21370	17585	30°
San Angelo, Tx.	SJT	145	(21.6)	9.0	(39.5)	16	1890	19890	18000	250°
San Antonio, Tx.	SAT	140	(21.5)	4.3	(36.3)	16	1160	19160	18000	190°
Texico, Tx.	TXO	147	(21.7)	10.0	(40)	15	4060	22060	18000	60°
Truth or Consequences, N.M.	TSC	118	(20.7)	9.7	(39.9)	15	4903	22900	17997	360°
Tucumcari, N.M.	TCC	136	(21.3)	9.5	(39.8)	15	4070	22070	18000	90°
Tulsa, OK.	TUL	115	(20.6)	6.0	(37.8)	17	790	18790	18000	190°
Waco, Tx.	ACT	150	(21.8)	6.0	(37.8)	16	536	18500	17964	180°
Wink, Tx.	INK	147	(21.7)	10.0	(40)	16	2870	22870	20000	180°

TABLE 3, MEASUREMENT EQUIPMENT CHARACTERISTICS

TACAN

Receiver:	Sierra Test Set and King 7000, No. 2 RCVR, SN Unknown
Antenna:	AT-741 B/A
Antenna Gain:	Approximately 1.5 dBi Mainbeam
Cable Loss:	Approximately 2.5 dB between the Antenna Output and the Receiver Input.
Calibration Point:	At the Antenna Output
Calibration Curve:	Figure C 21

VOR

Receiver:	No. 2 RCVR, Bendix 4165.3A, SN 1153
Antenna:	37J Mounted above the Cabin
Antenna Gain:	Approximately 0.5 dBi Mainbeam
Cable Loss:	Approximately 0.5 dB between the Antenna Output and the Signal Splitter Input; Approximately 3.5 dB between the Input to the Signal Splitter and the Receiver Input.
Calibration Point:	At the Input to the Signal Splitter
Calibration Curve:	Figure A 21

includesthe effect of the airborne antenna). This is equivalent to assuming an isotropic airborne antenna. This was done for several reasons:

a. Measured antenna patterns are not available for this particular antenna on this particular aircraft.

b. Measured data for a similar antenna mounted at a similar position on a similar aircraft are not available in any large quantity.

c. The airborne antenna pattern is a complex, three dimensional variable. When precise patterns are available, they often show large variations over small angle changes. The angle of interest changes with movement of the aircraft. Motion averaging takes place as the aircraft changes its orientation in space and its position with respect to the ground facility. As a result, the airborne antenna pattern is a difficult variable to handle even when it is precisely available.

For these reasons, we decided not to try to account for the antenna pattern effects by adjusting either measured or predicted data. Those reading this report should feel free to apply their knowledge of airborne antennas to the data comparison as they feel appropriate.

In general, there is good correlation between the measured and the predicted VOR data. Measured VOR data from two of the facilities (Junction, Tx. and San Antonio, Tx.) fell predominately above the 5 per cent prediction. While this in itself is not unexpected, the measured data looks unusual because there appears to be little or no fall-off in signal strength as a function of distance. Measured VOR data from one of the facilities (Abilene, Tx.) fell predominately below the 95 per cent prediction. This signal, however, does fall-off as a function of distance. Most of the measured VOR data fell between the 5 per cent and 95 per cent prediction limits.

In Appendix B, the measured VOR signal is plotted in microvolts. Since the VOR receiver was calibrated at the input to the signal splitter, the measured data is referenced to this point. The plotted data in Appendix B ignores the 3.5 dB loss between the input to the signal splitter and the receiver.

TACAN DATA COMPARISON

Appendix C shows a comparison of ITS predictions of available TACAN signal in space and measured antenna output. The predictions were made for general variability, 4/3 smooth earth. Since the measurement system was calibrated at the antenna output, the measured data represents the signal level at the antenna output. No adjustment of measured data was required. Since the cable losses amount to 2.5 dB, the signal would be that much smaller at the receiver input. Appendix C is therefore a comparison of signal in space (which does not include the airborne antenna) with measured data at the antenna output (which necessarily includes the effect of the airborne antenna). This is equivalent to assuming an isotropic airborne antenna. The reasons for this are similar to those given for the VOR situation with one exception. Detailed antenna patterns are available for five L-band (960-1215 MHz) antennas on a Sabreliner. While it is not appropriate to apply them directly

to the measured data in this report, they are representative of the general nature of L-band antenna patterns and they point out how antenna patterns can be difficult to use even when precise measurements are available.

In general, there is good correlation between the measured and the predicted TACAN data. The TACAN data is far more jagged than the VOR data. This may be due to signal multipath or it may be due to nulls in the airborne antenna pattern. In spite of this, the majority of the data falls between the five percent and 95 percent prediction limits.

DIFFERENCES BETWEEN INBOUND AND OUTBOUND FLIGHTS

There are clear differences between data collected on inbound and outbound flights. Data collected on inbound flights is noticeably larger. On the average, inbound VOR data is 5.5 dB larger than the outbound data. Similarly, the inbound TACAN data is 2.1 dB larger than the outbound data. Signal strength differences are attributed to differences between the airborne antenna pattern gains off the nose and off the tail. The calculations used to quantifity these differences are shown in Appendix D..

DATA COMPARISONS CONSIDERING SPECIFIC TERRAIN

Appendix G shows a comparison of ITS predictions of available VOR signal in space and measured antenna output. Appendix H shows a comparison for TACAN. The measured data are the same as that in Appendixes A and C. The predicted data are different in that they attempt to include the effects of the specific terrain on each radial flown. Since the terrain is different at each site, the predictions are different as well. Consequently, it is no longer possible to compare predictions and all measured data on only four graphs as is done in Figures 1 through 4. This results in a very limited amount of measured data for each case. The amount of data is not sufficient to discuss correlation. For this reason, this data does not allow any conclusive statements concerning the model's ability to consider specific terrain.

One way to validate the terrain sensitivity of the model, would be to take ten inbound and outbound runs on each radials flown. This could be done for a number of radials on a number of facilities. With such an approach, it would be advisable to choose sites with wide variations in terrain, from very flat to very mountainous. There does not appear to be a pressing need to do this work at this time.

Consideration of local terrain is a time consuming process, even when it is done for only one radial. The frequency

(13)

assignment process must consider the entire service volume of all affected facilities. To consider local terrain for routine frequency assignments would require an automated process. This could be done by extending and validating present capabilities. At this time, however, this does not appear to be necessary or cost effective.

CONCLUSIONS AND RECOMMENDATIONS

1. For both VOR and DME/TACAN, there is a good correlation between the measured data and the predicted data without giving special consideration to terrain. The ITS model is therefore, the appropriate tool to use for coverage predictions for such projects as second generation VORTAC and the update of the National Standard on the VORTAC system.

2. When a signal strength prediction is required for a large number of terrain conditions, we recommend that "Four Thirds Smooth Earth" and 95 percent availability be specified as input parameters to the model.

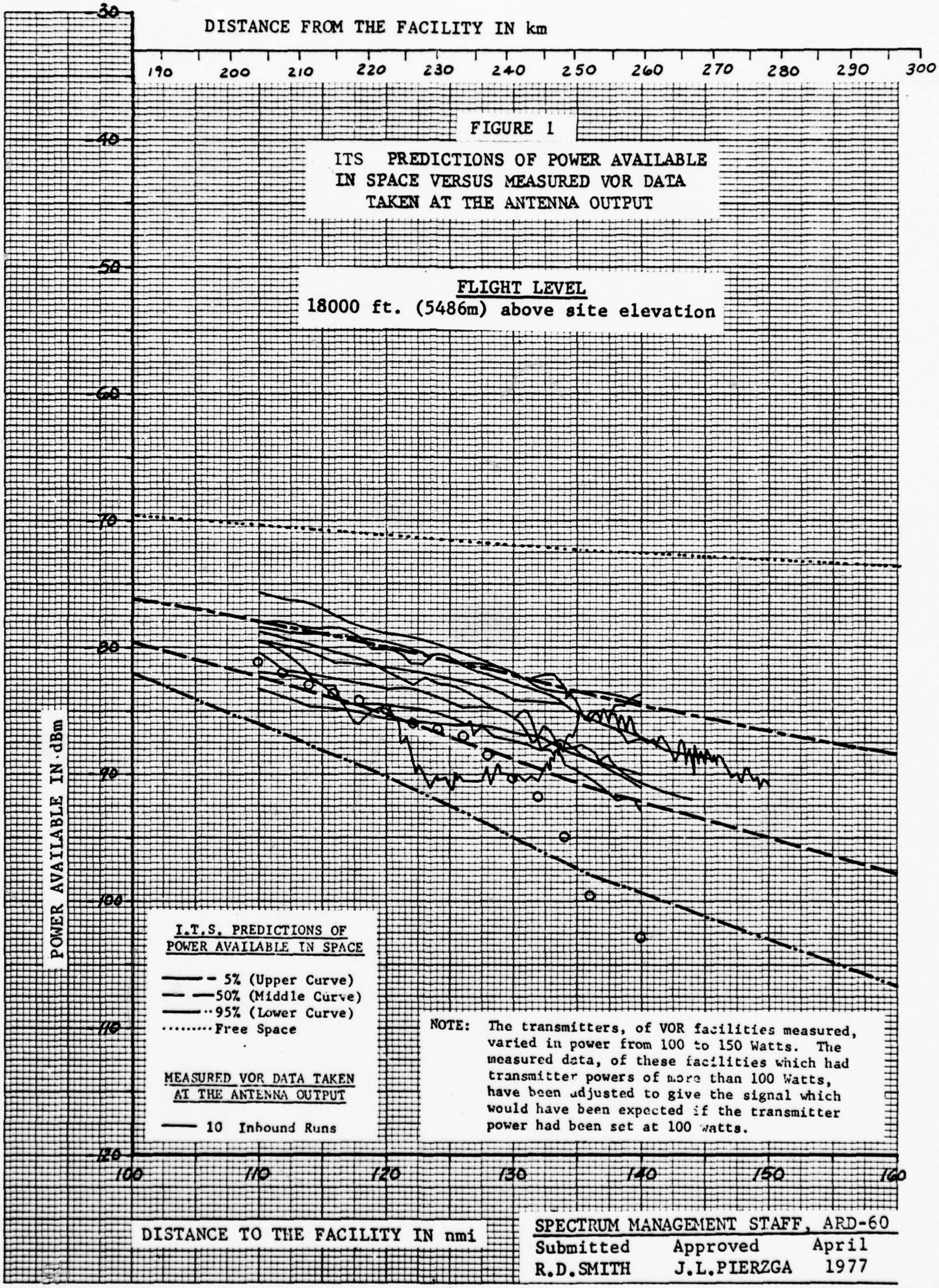
3. With a minimum allowable VOR transmitter power of 100 watts, the VOR signal strength in space at the critical point of the high altitude service volume (18000' (5486 m), 130 nmi. (240 km)) does not meet the requirements of the present National Standard (-111 dBw/m^2 = -84 dBm).

4. With a minimum allowable TACAN transmitter power of 5000 watts, the TACAN signal strength in space at the critical point of the high altitude service volume (18000' (5486 m), 130 nmi. (240 km)) does not meet the requirements of the present National Standard (-86 dBw/m^2 = -78.5 dBm).

5. Since a very limited amount of data was taken at each site, no conclusive statements can be made concerning the model's ability to account for specific terrain.

6. Consideration of specific terrain is a time consuming process involving a certain amount of judgement. At this time, it does not appear beneficial to consider terrain in the routine FAA frequency assignment process.

7. The airborne antenna pattern is the most difficult parameter to handle. The high correlation between predicted power available in space and measured antenna output indicates that assuming an isotropic airborne pattern is not unreasonable. Comparison of the composite data plots indicate that these particular antennas are slightly above isotropic for the inbound flights and slightly less than isotropic for the outbound flights.


DISTANCE FROM THE FACILITY IN km
190 200 210 220 230 240 250 260 270 280 290 300
FIGURE 1
ITS PREDICTIONS OF POWER AVAILABLE IN SPACE VERSUS MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
FLIGHT LEVEL
18000 ft. (5486m) above site elevation
-30 -40 -50 -60 -70 -80 -90 -100 -110 -120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
10 Inbound Runs
NOTE: The transmitters, of VOR facilities measured, varied in power from 100 to 150 Watts. The measured data, of these facilities which had transmitter powers of more than 100 Watts, have been adjusted to give the signal which would have been expected if the transmitter power had been set at 100 watts.
100 110 120 130 140 150 160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved April
R.D.SMITH J.L.PIERZGA 1977

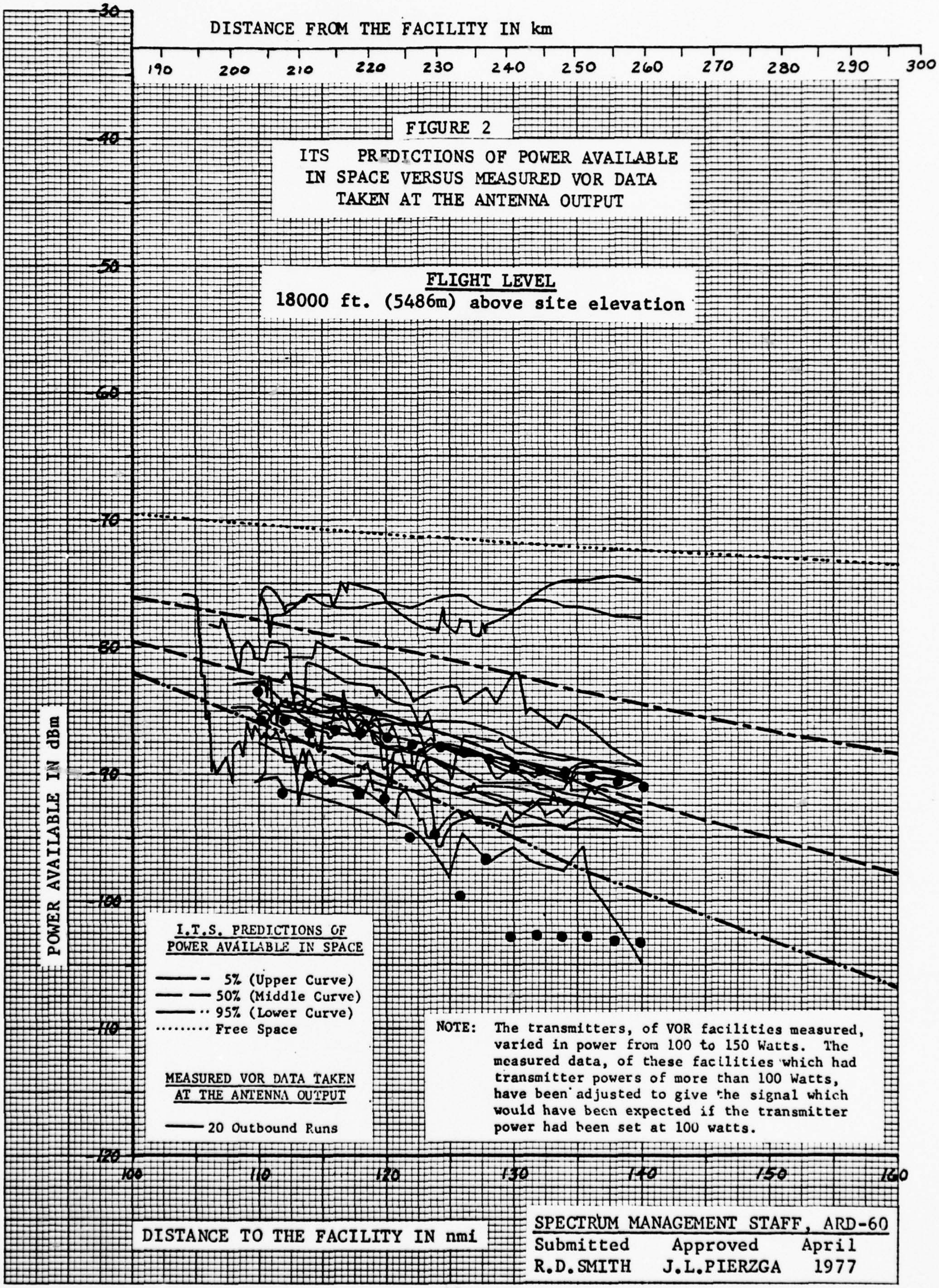


FIGURE 2
ITS PREDICTIONS OF POWER AVAILABLE IN SPACE VERSUS MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
DISTANCE FROM THE FACILITY IN km
190 200 210 220 230 240 250 260 270 280 290 300
FLIGHT LEVEL
18000 ft. (5486m) above site elevation
POWER AVAILABLE IN dBm
-30 -40 -50 -60 -70 -80 -90 -100 -110 -120
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
20 Outbound Runs
NOTE: The transmitters, of VOR facilities measured, varied in power from 100 to 150 Watts. The measured data, of these facilities which had transmitter powers of more than 100 Watts, have been adjusted to give the signal which would have been expected if the transmitter power had been set at 100 watts.
100 110 120 130 140 150 160
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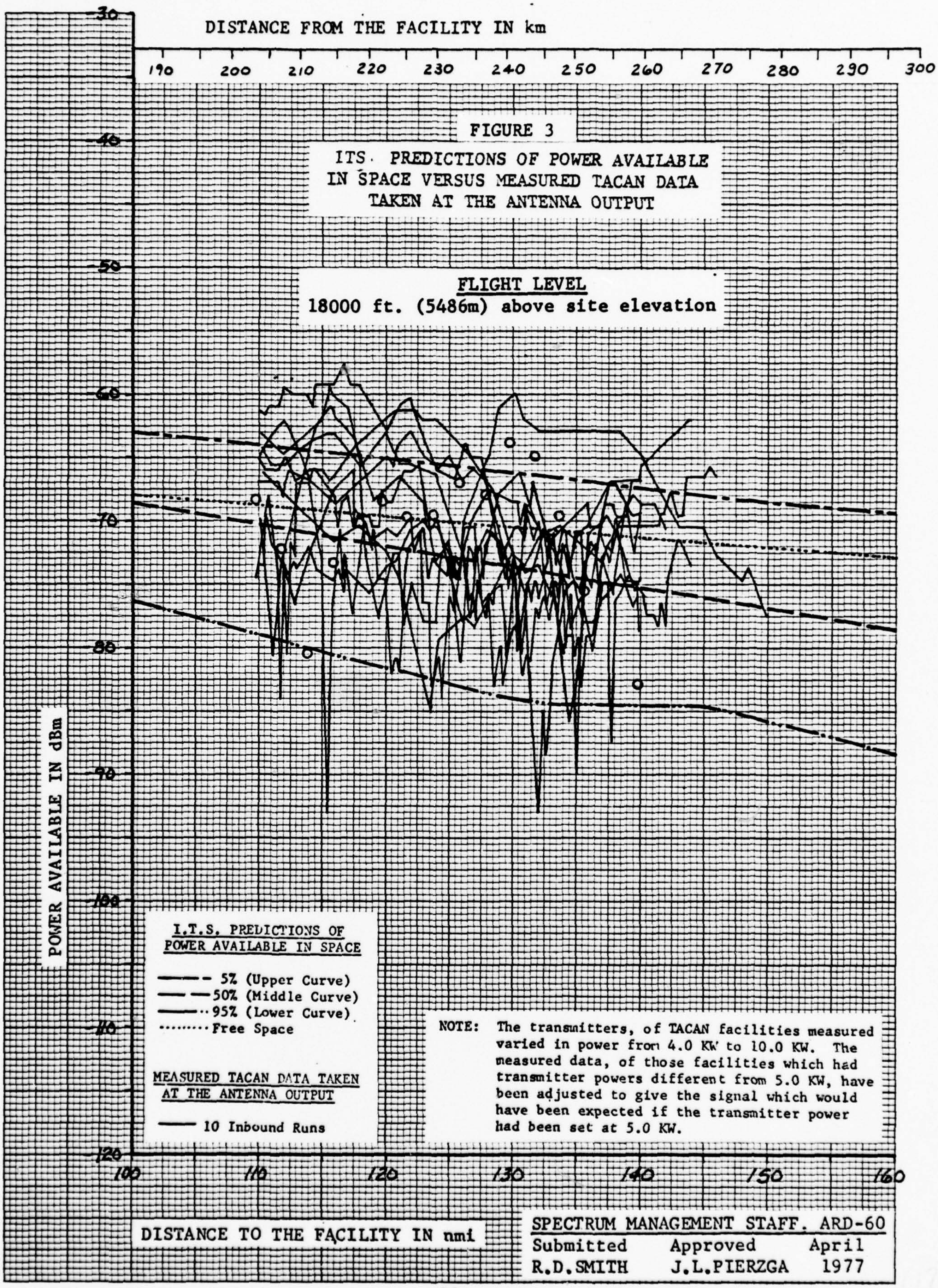
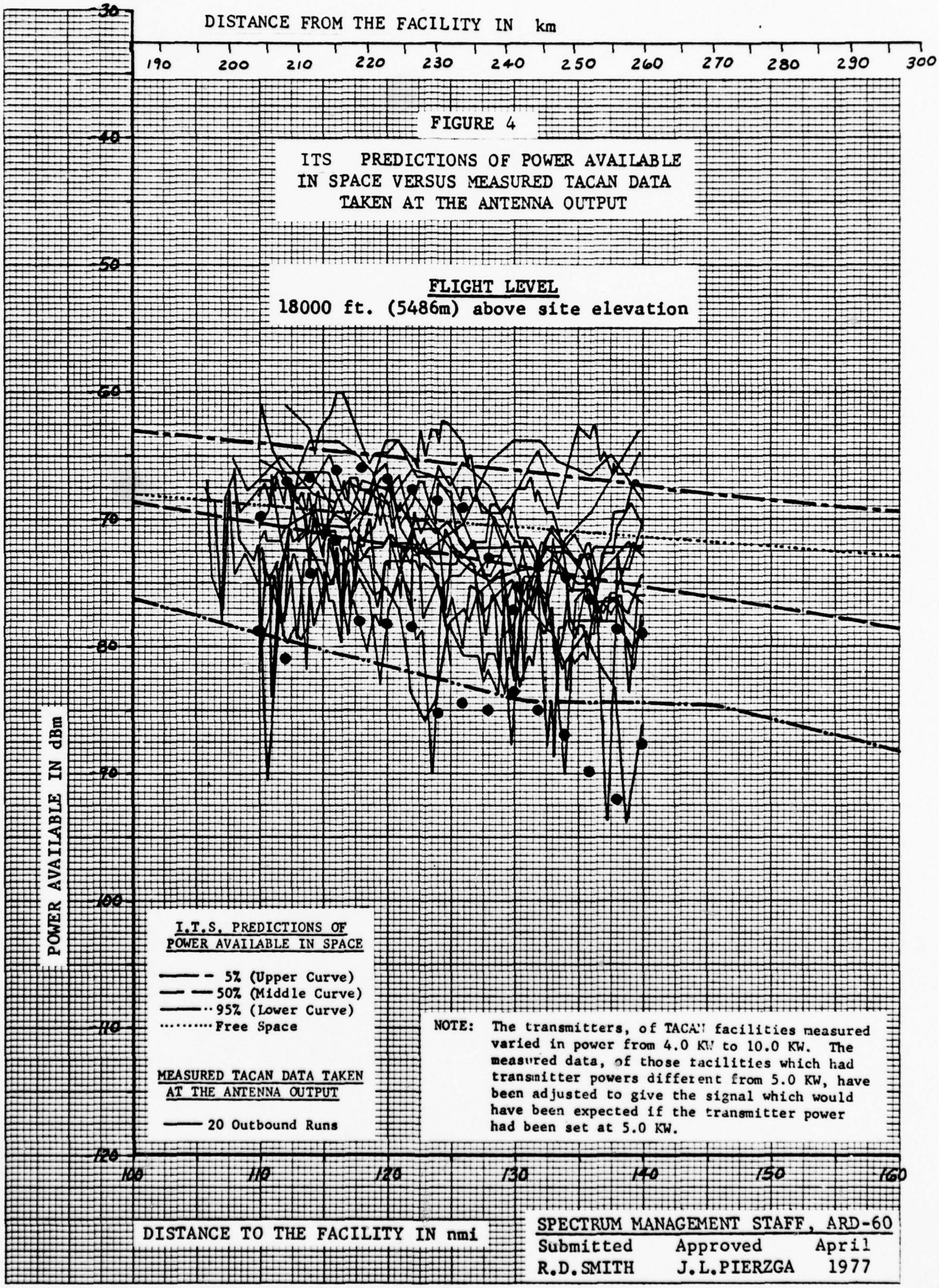


FIGURE 3

ITS PREDICTIONS OF POWER AVAILABLE IN SPACE VERSUS MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT


DISTANCE FROM THE FACILITY IN km
190 200 210 220 230 240 250 260 270 280 290 300
FIGURE 4
ITS PREDICTIONS OF POWER AVAILABLE IN SPACE VERSUS MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
FLIGHT LEVEL
18000 ft. (5486m) above site elevation
-30 -40 -50 -60 -70 -80 -90 -100 -110 -120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
20 Outbound Runs
NOTE: The transmitters, of TACAN facilities measured varied in power from 4.0 KW to 10.0 KW. The measured data, of those facilities which had transmitter powers different from 5.0 KW, have been adjusted to give the signal which would have been expected if the transmitter power had been set at 5.0 KW.
100 110 120 130 140 150 160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted R.D.SMITH
Approved J.L.PIERZGA
April 1977

REFERENCES

1. FAA letter, AAF-400 to AFS-700, Subject: Second Generation VORTAC Power Levels, Dated June 11, 1975.

2. FAA letter, OKC FIFO to AFS-570, Subject: Second Generation VORTAC Power Level, Dated July 11, 1975.

3. FAA letter, ARD-300 to ATF-4/AFS-720/AAF-410, Subject: Update of the National Aviation Standard for the VORTAC System, Dated Dec. 20, 1976.

4. Gierhart, G. D. and M. E. Johnson, Computer Programs for Air/Ground Propagation and Interference Analysis, FAA-RD-73-103.

5. Gierhart, G. D. and M.E. Johnson, Propagation Model Extensions for 1977 Computer Programs, FAA-RD-77-129

6. Johnson, M. E. and G. D. Gierhart, Applications Guide, Propagation and Interference Analysis Computer Programs, FAA-RD-77-60.

ACRONYMS

AAF-400	Airway Facilities Nav/Com Engin. Division
AAF-410	Airway Facilities Navaids Branch
AGC	Automatic Gain Control
ARD-60	FAA Spectrum Management Staff
dB	Decibels
dBi	Antenna Gain Relative to an istropic Antenna
dBm	Decibels Relative to a Milliwatt
dBw	Decibels Relative to a Watt
DME	Distance Measuring Equipment
EIRP	Equivalent Isotropic Radiated Power
FAA	Federal Aviation Administration
FIFO	Flight Inspection Field Office
H	High Altitude (A Class of Navigation Facility)
H1	Height of Ground Antenna above Site Elevation
H2	Height of Aircraft above MSL
IDENT	Facility Identifier
ITS	Institute of Telecommunication Sciences
km	Kilometer (0.6214 nmi.)
KW	Kilowatt
MHz	Megahertz
MSL	Mean Sea Level
nmi.	Nautical Mile (1.852 Kilometers)
OKC	Oklahoma City
RCVR	Receiver
RTA-2	A TACAN Antenna Nomenclature

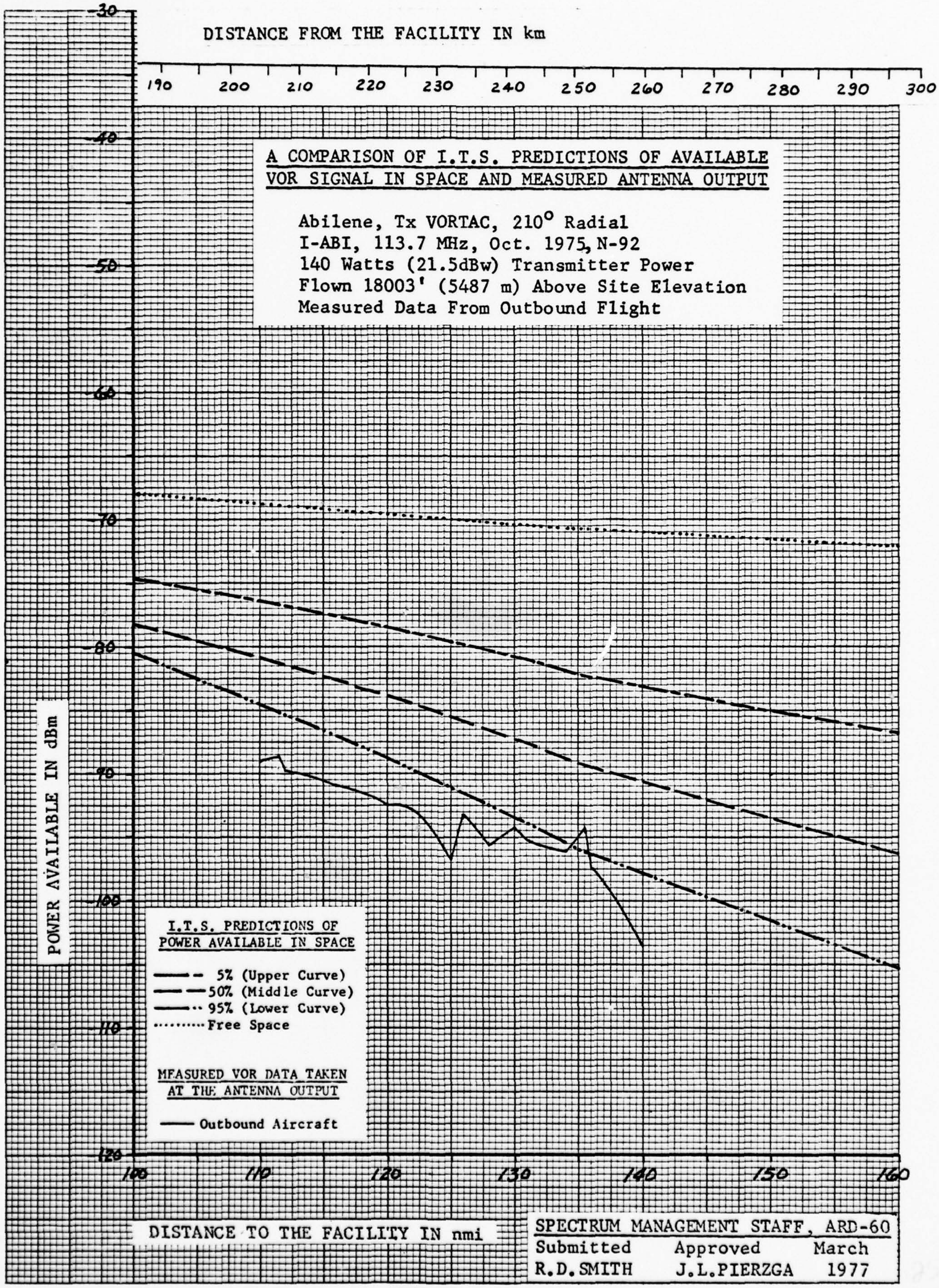
20

SN	Serial Number
SRDS	Systems Research and Development Service
TACAN	UHF Tactical Air Navigation Facility
VOR	VHF Omnirange Facility
VORTAC	A Combined VOR and TACAN Facility
W	Watt

APPENDIX A

COMPARISON OF ITS PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT

Appendix A shows a comparison of predicted and measured data. The predicted data is based on the ITS computer outputs shown in Appendix E. Adjustments to the predictions have been made in order to account for slight differences in station EIRP's. Since many stations differed in EIRP by less than 1.0 dB, it seemed pointless to make 20 computer runs when 5 would suffice. The measured data has been adjusted in order to compensate for cable loss between the antenna output and the calibration point. Consequently, the data shown is actually 0.5 dB greater than the raw measured data (See Table 3, page 5).



DISTANCE FROM THE FACILITY IN km
190 200 210 220 230 240 250 260 270 280 290 300
A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Abilene, Tx VORTAC, 210° Radial
I-ABI, 113.7 MHz, Oct. 1975, N-92
140 Watts (21.5dBw) Transmitter Power
Flown 18003' (5487 m) Above Site Elevation
Measured Data From Outbound Flight
-30 -40 -50 -60 -70 -80 -90 -100 -110 -120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
100 110 120 130 140 150 160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved March
R.D.SMITH J.L.PIERZGA 1977

FIGURE A 1

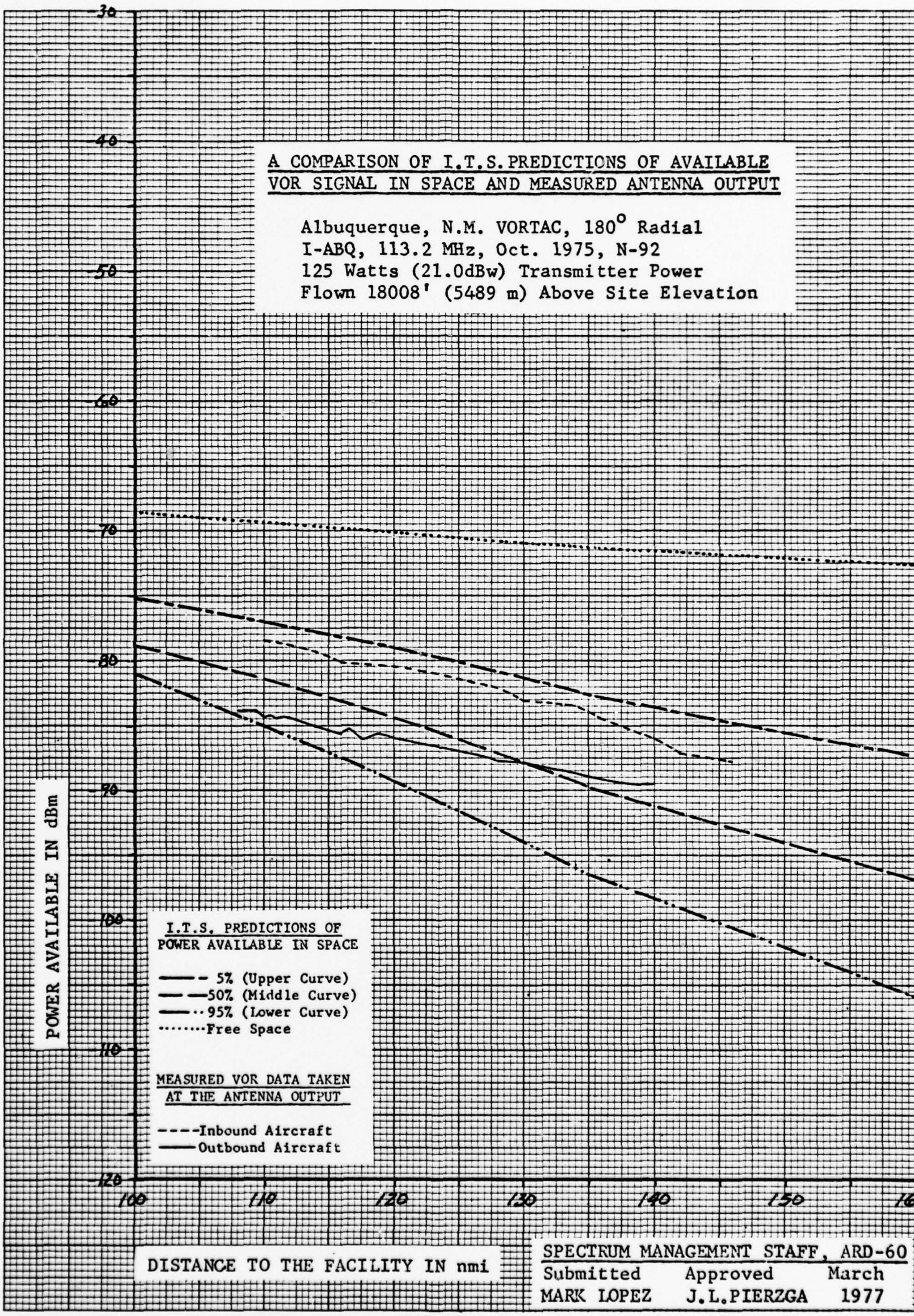
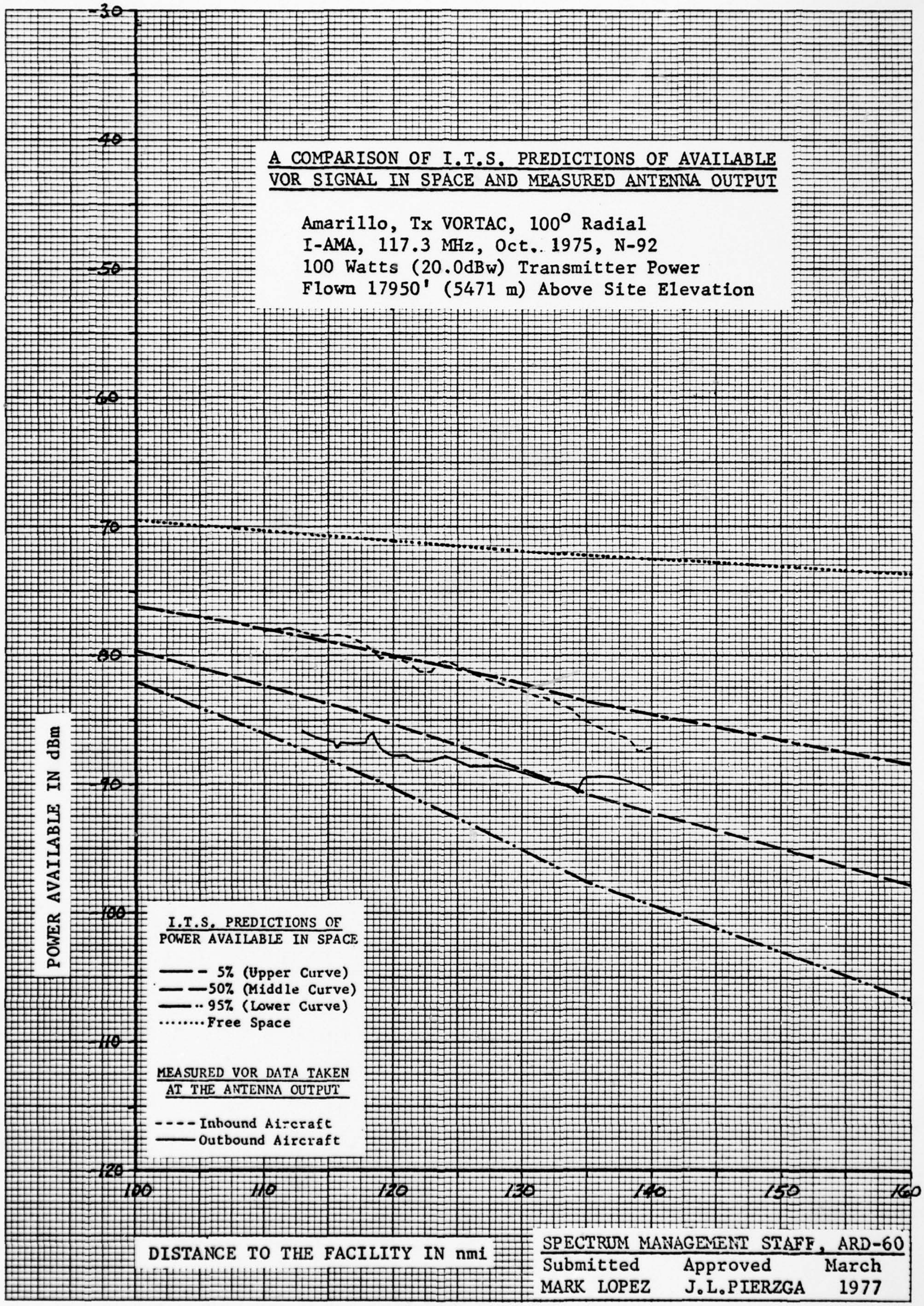

A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Albuquerque, N.M. VORTAC, 180° Radial
I-ABQ, 113.2 MHz, Oct. 1975, N-92
125 Watts (21.0dBw) Transmitter Power
Flown 18008' (5489 m) Above Site Elevation
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved March
MARK LOPEZ J.L.PIERZGA 1977

FIGURE A 2


A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Amarillo, Tx VORTAC, 100° Radial
I-AMA, 117.3 MHz, Oct. 1975, N-92
100 Watts (20.0dBw) Transmitter Power
Flown 17950' (5471 m) Above Site Elevation
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
POWER AVAILABLE IN dBm
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
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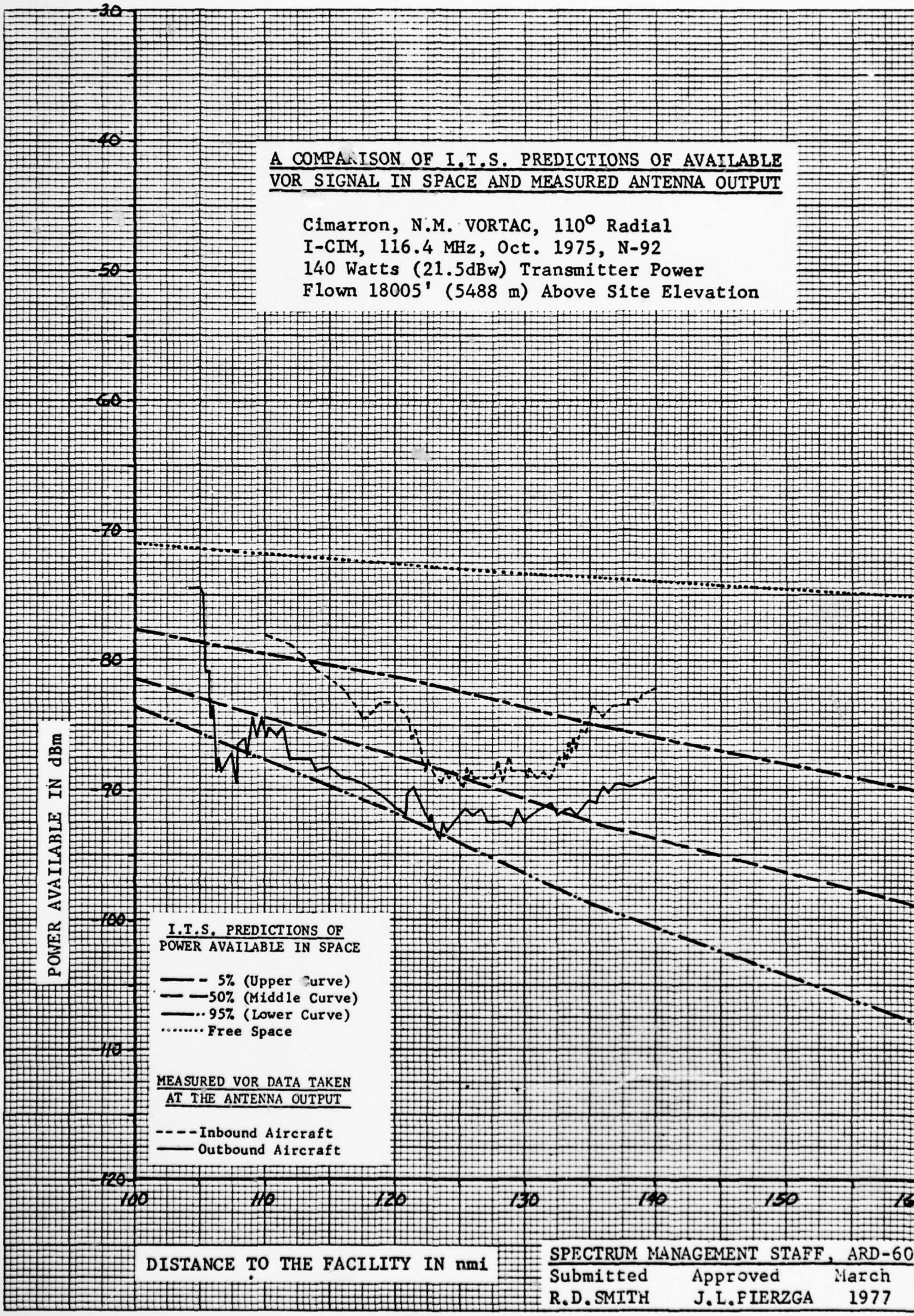
1977

FIGURE A 3



A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Cimarron, N.M. VORTAC, 110° Radial
I-CIM, 116.4 MHz, Oct. 1975, N-92
140 Watts (21.5dBw) Transmitter Power
Flown 18005' (5488 m) Above Site Elevation
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
100
110
120
130
140
150
160
POWER AVAILABLE IN dBm
DISTANCE TO THE FACILITY IN nmi
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
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J.L.FIERZGA
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FIGURE A 4

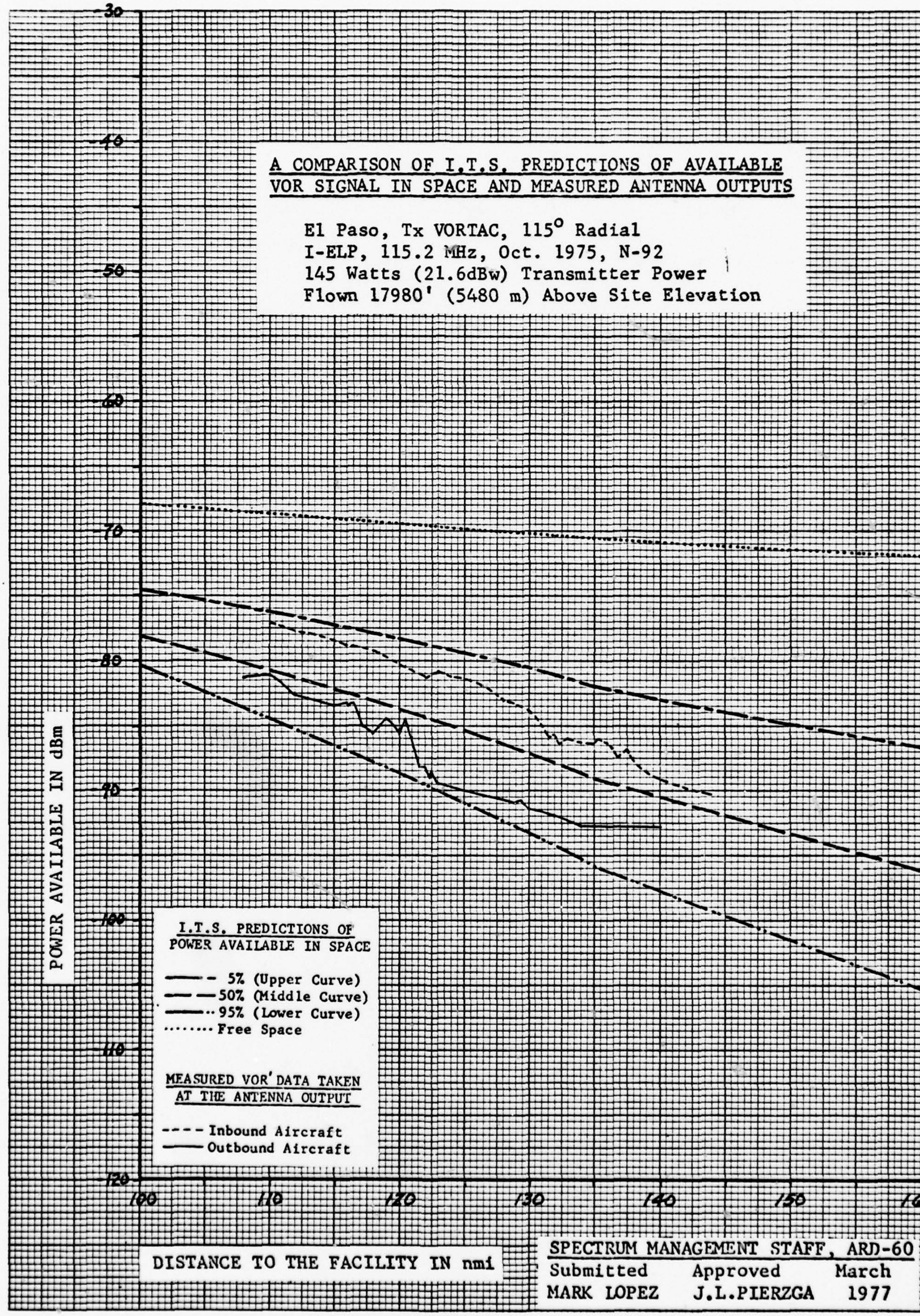
A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUTS
El Paso, Tx VORTAC, 115° Radial
I-ELP, 115.2 MHz, Oct. 1975, N-92
145 Watts (21.6dBw) Transmitter Power
Flown 17980' (5480 m) Above Site Elevation
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
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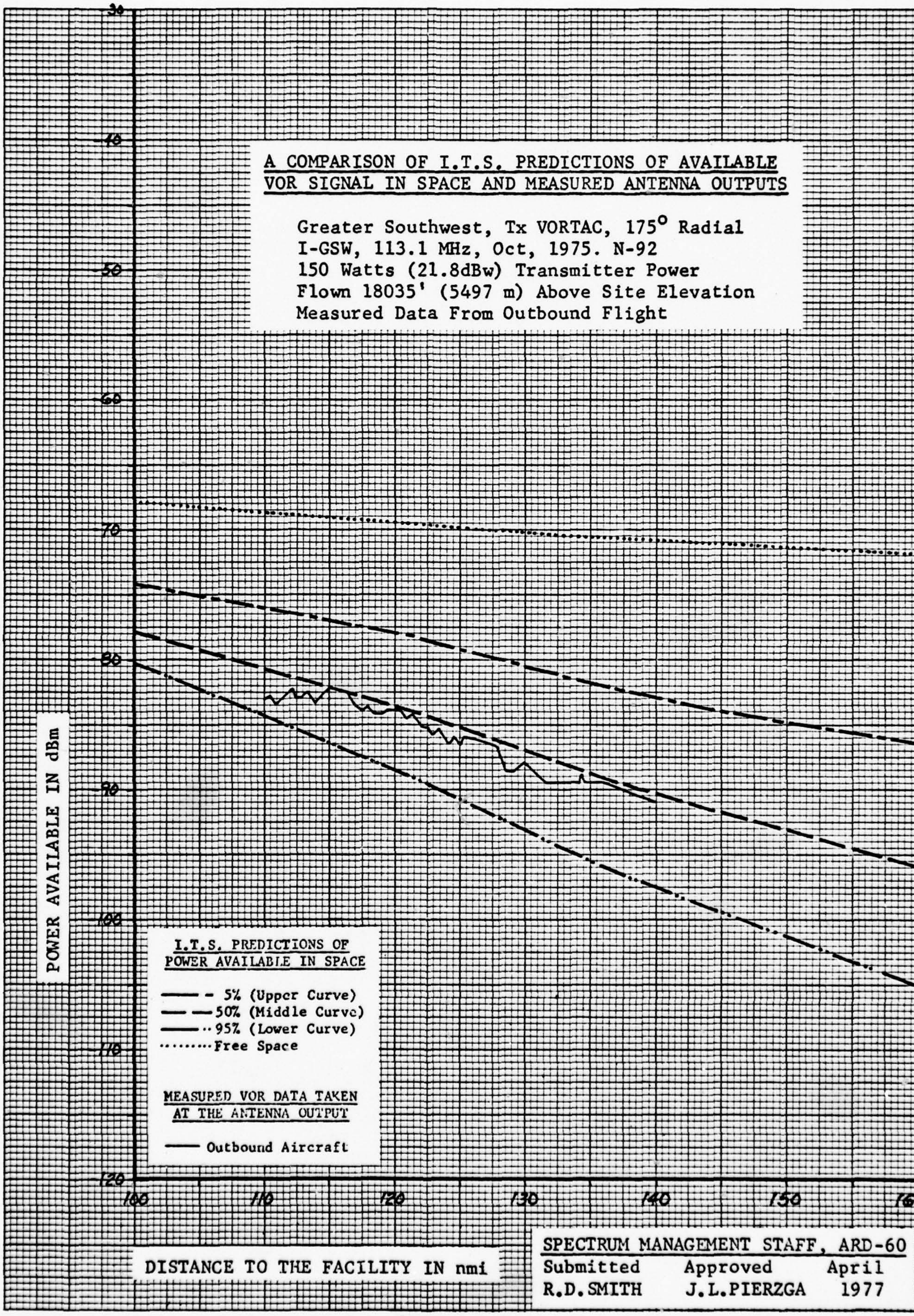
FIGURE A 5



A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUTS
Greater Southwest, Tx VORTAC, 175° Radial
I-GSW, 113.1 MHz, Oct, 1975. N-92
150 Watts (21.8dBw) Transmitter Power
Flown 18035' (5497 m) Above Site Elevation
Measured Data From Outbound Flight
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
POWER AVAILABLE IN dBm
30
40
50
60
70
80
90
100
110
120
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
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FIGURE A 6

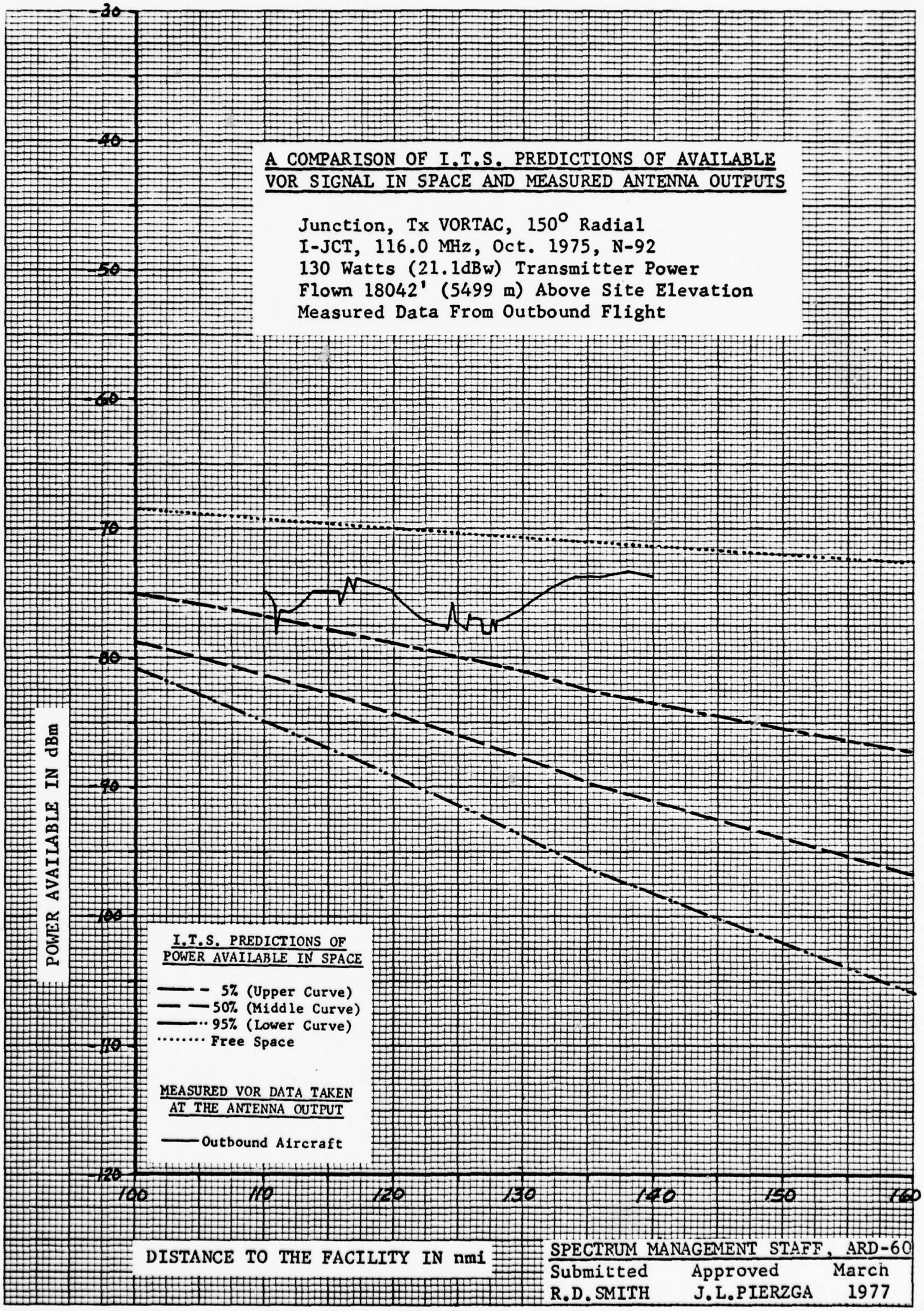
A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUTS
Junction, Tx VORTAC, 150° Radial
I-JCT, 116.0 MHz, Oct. 1975, N-92
130 Watts (21.1dBw) Transmitter Power
Flown 18042' (5499 m) Above Site Elevation
Measured Data From Outbound Flight
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
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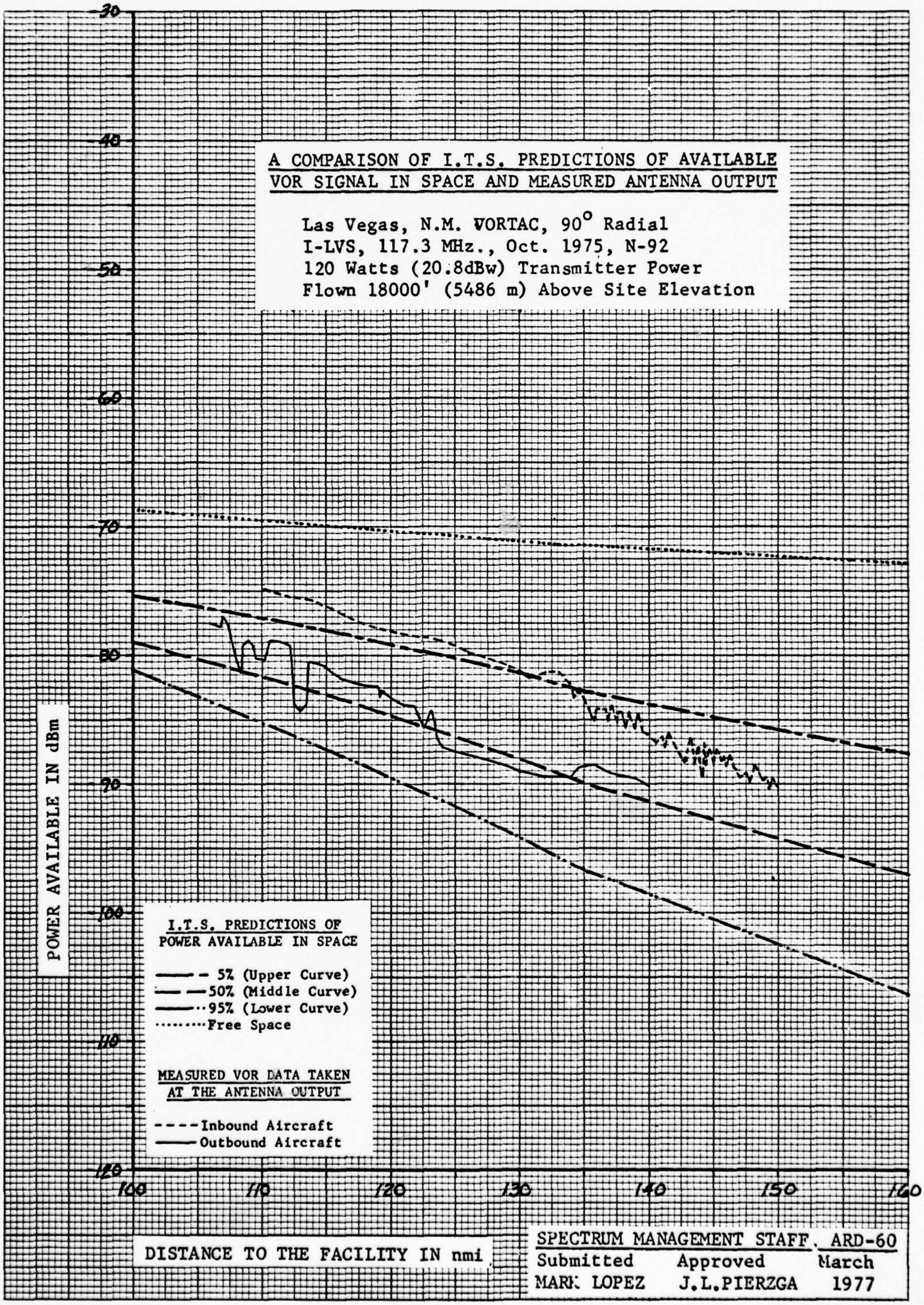
FIGURE A 7


A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Las Vegas, N.M. VORTAC, 90° Radial
I-LVS, 117.3 MHz., Oct. 1975, N-92
120 Watts (20.8dBw) Transmitter Power
Flown 18000' (5486 m) Above Site Elevation
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
MARK LOPEZ
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J.L.PIERZGA
March
1977

FIGURE A 8

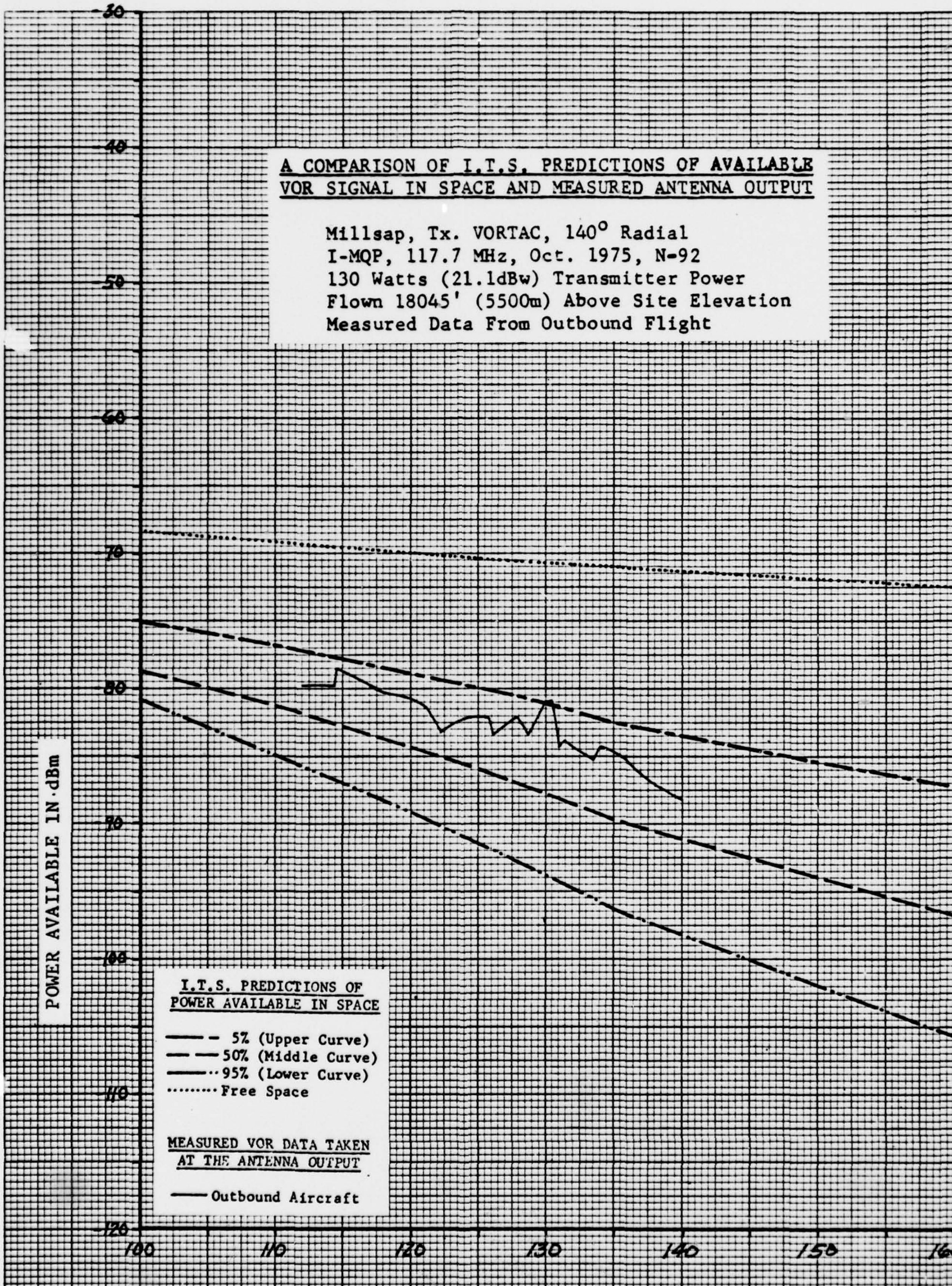

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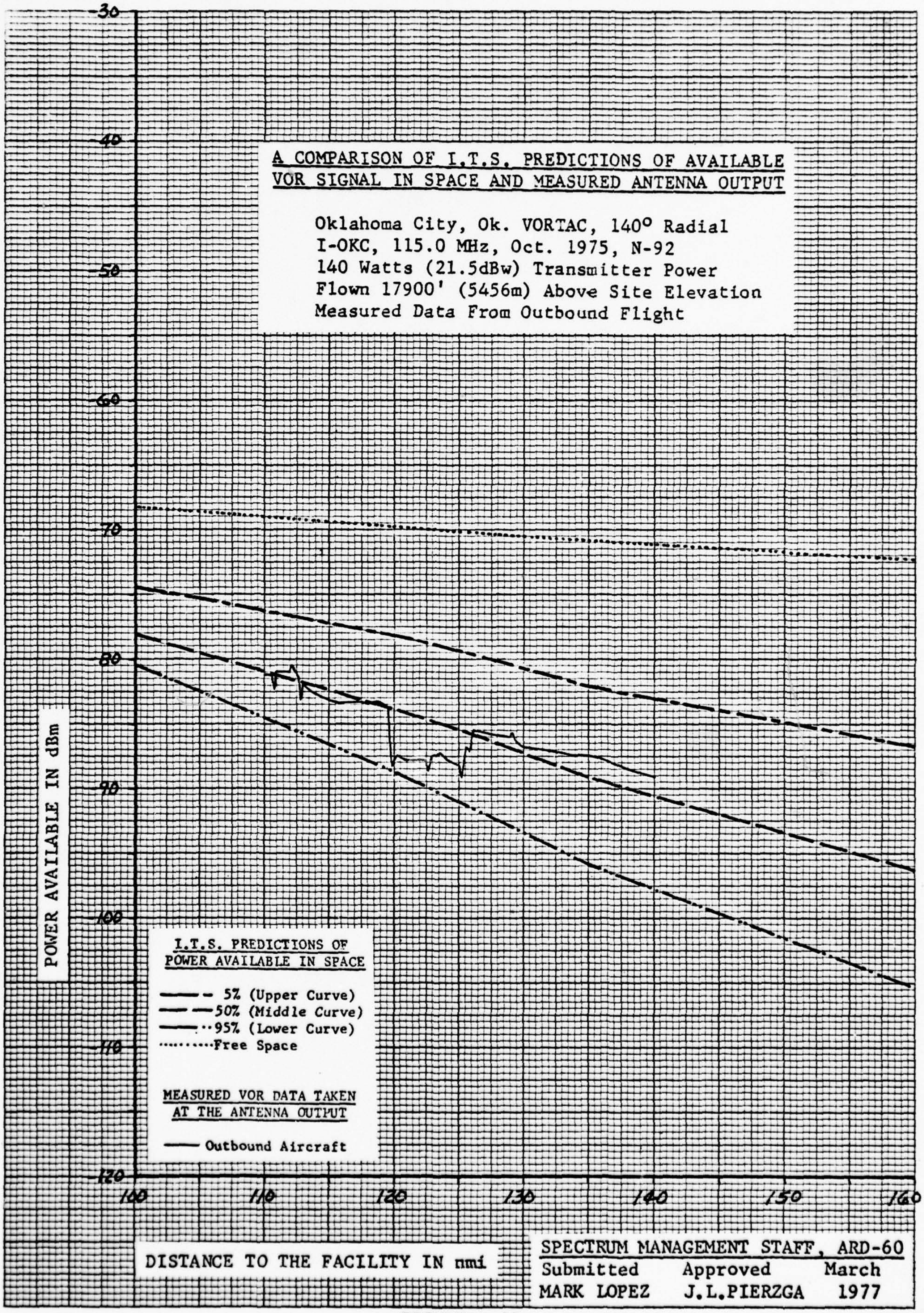
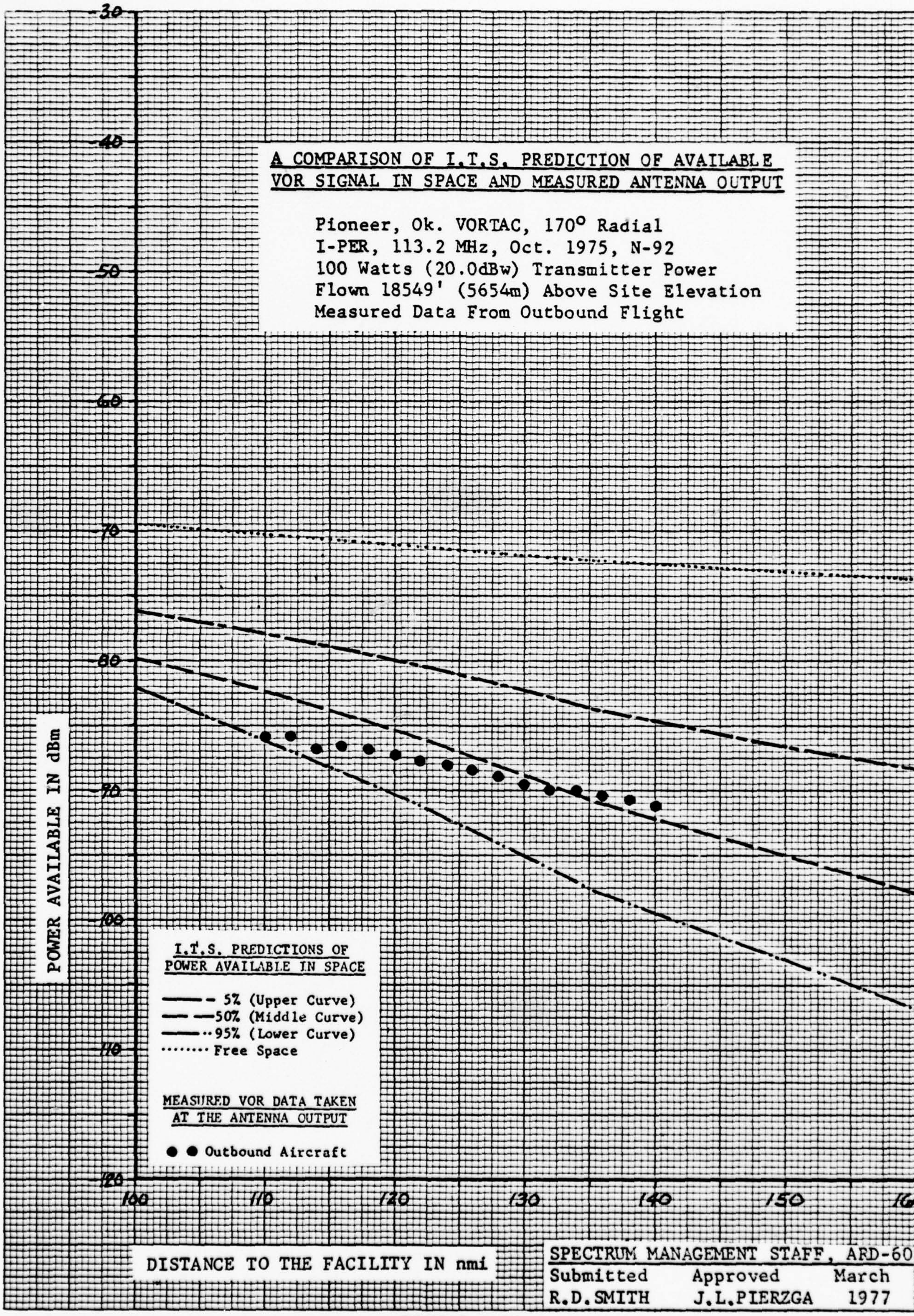
FIGURE A 9



A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Oklahoma City, Ok. VORTAC, 140° Radial
I-OKC, 115.0 MHz, Oct. 1975, N-92
140 Watts (21.5dBw) Transmitter Power
Flown 17900' (5456m) Above Site Elevation
Measured Data From Outbound Flight
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved March
MARK LOPEZ J.L.PIERZGA 1977

FIGURE A 10


A COMPARISON OF I.T.S. PREDICTION OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Pioneer, Ok. VORTAC, 170° Radial
I-PER, 113.2 MHz, Oct. 1975, N-92
100 Watts (20.0dBw) Transmitter Power
Flown 18549' (5654m) Above Site Elevation
Measured Data From Outbound Flight
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
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Approved
J.L.PIERZGA
March
1977

FIGURE A 11

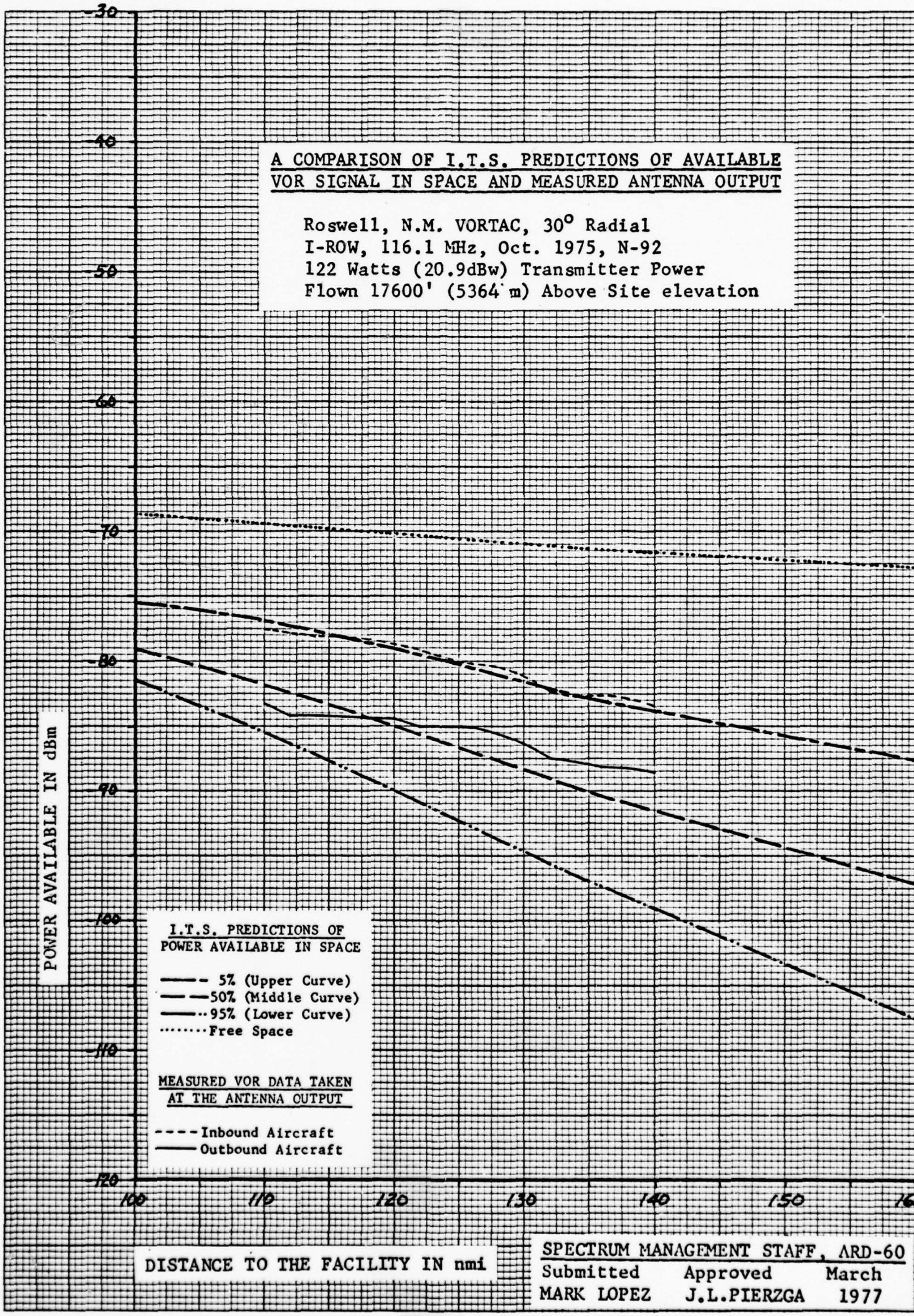
A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Roswell, N.M. VORTAC, 30° Radial
I-ROW, 116.1 MHz, Oct. 1975, N-92
122 Watts (20.9dBw) Transmitter Power
Flown 17600' (5364 m) Above Site elevation
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
POWER AVAILABLE IN dBm
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
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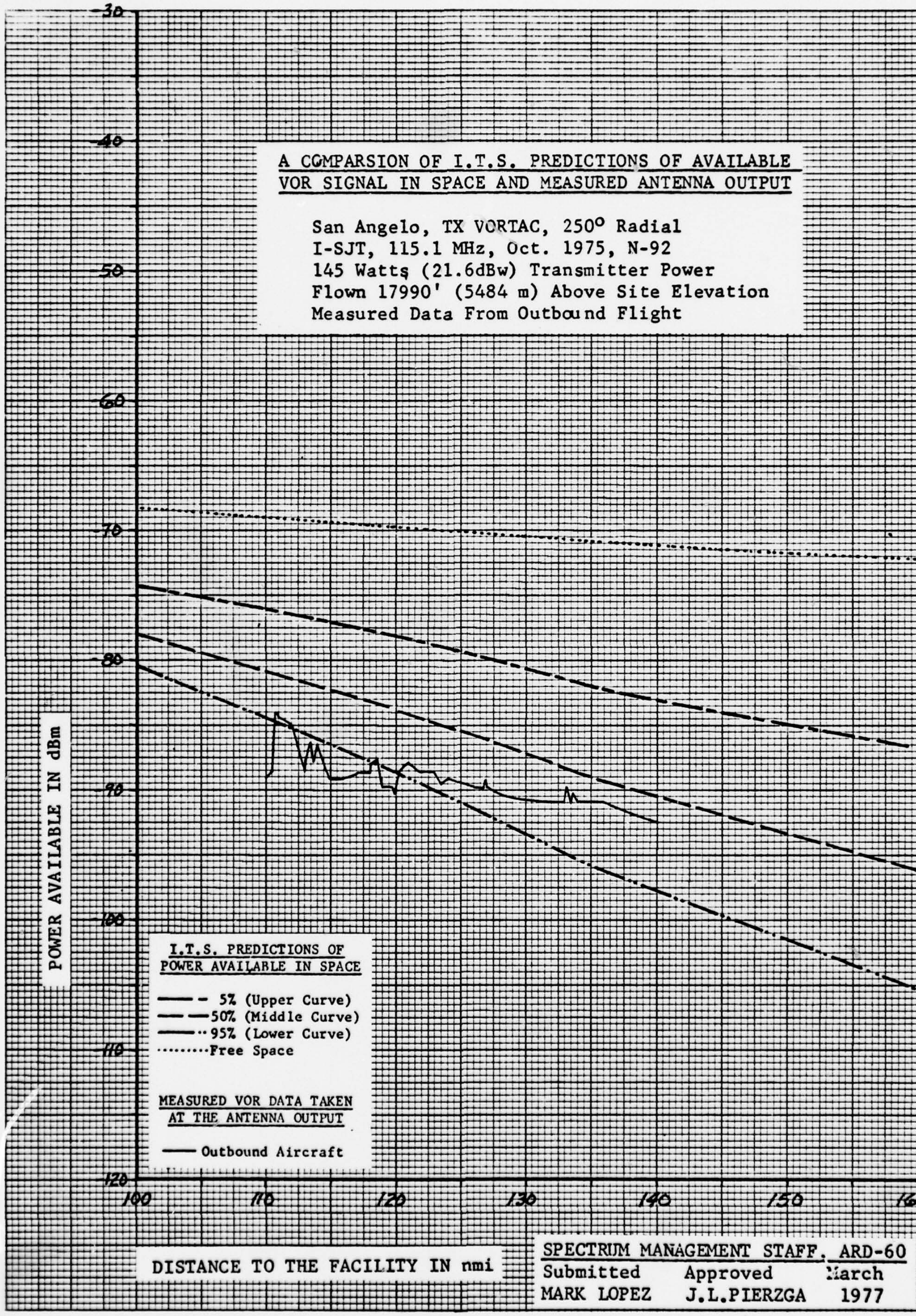
FIGURE A 12



A COMPARSION OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
San Angelo, TX VORTAC, 250° Radial
I-SJT, 115.1 MHz, Oct. 1975, N-92
145 Watts (21.6dBw) Transmitter Power
Flown 17990' (5484 m) Above Site Elevation
Measured Data From Outbound Flight
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
MARK LOPEZ
Approved
J.L.PIERZGA
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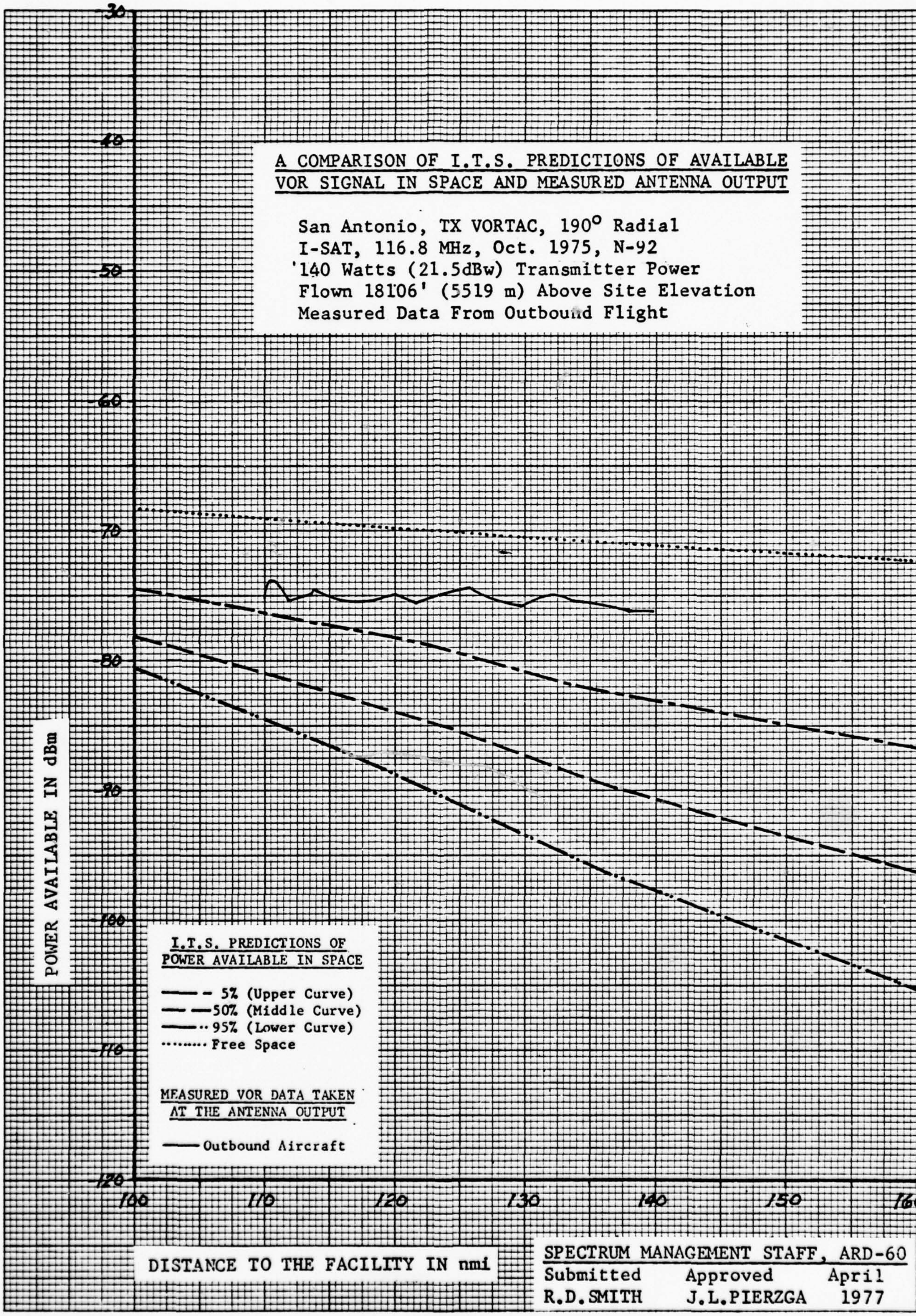
FIGURE A 13



A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE
VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
San Antonio, TX VORTAC, 190° Radial
I-SAT, 116.8 MHz, Oct. 1975, N-92
140 Watts (21.5dBw) Transmitter Power
Flown 18106' (5519 m) Above Site Elevation
Measured Data From Outbound Flight
I.T.S. PREDICTIONS OF
POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN
AT THE ANTENNA OUTPUT
Outbound Aircraft
POWER AVAILABLE IN dBm
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
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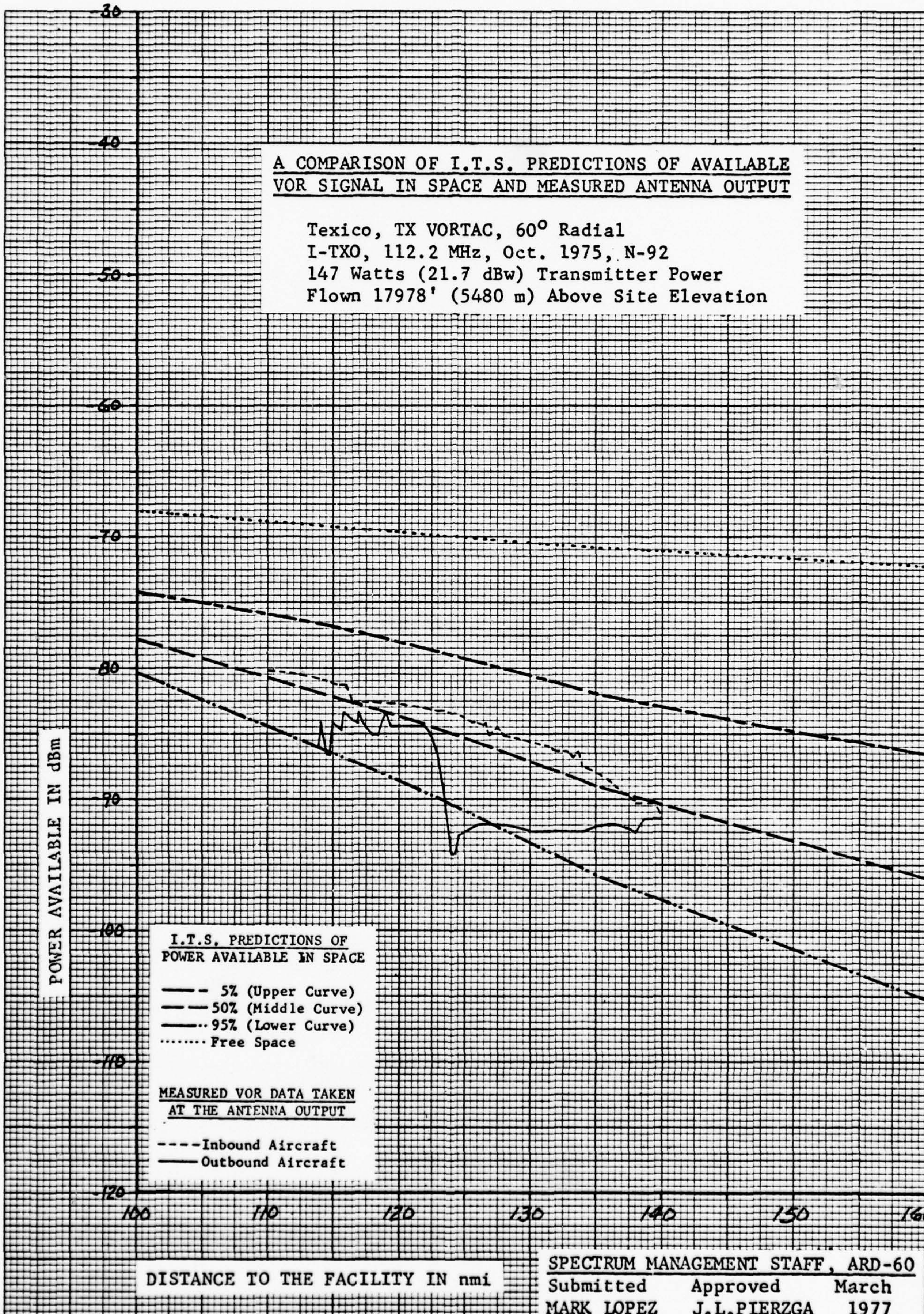
FIGURE A 14



A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Texico, TX VORTAC, 60° Radial
I-TXO, 112.2 MHz, Oct. 1975, N-92
147 Watts (21.7 dBw) Transmitter Power
Flown 17978' (5480 m) Above Site Elevation
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
MARK LOPEZ
Approved
J.L.PIERZGA
March
1977

FIGURE A 15

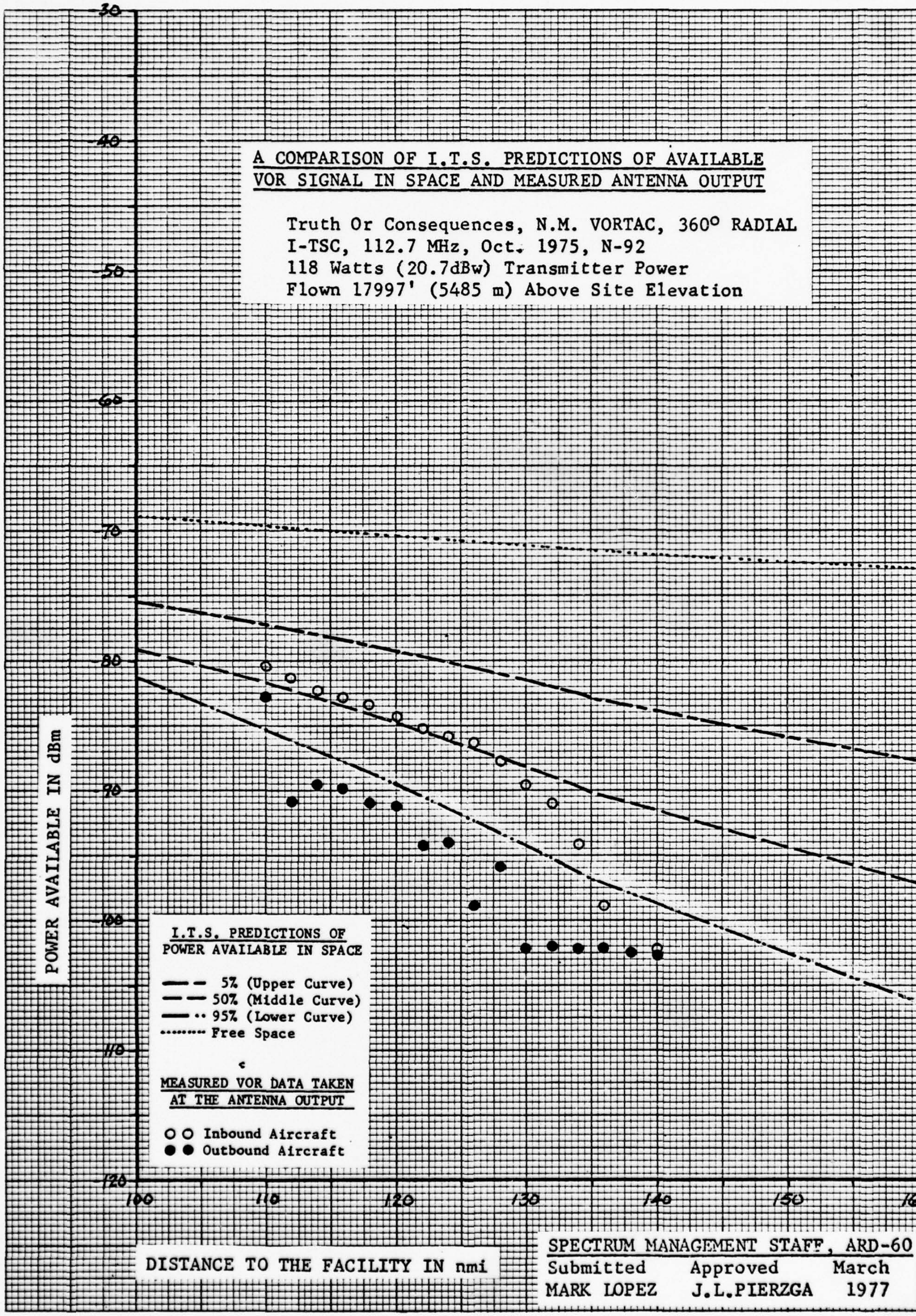
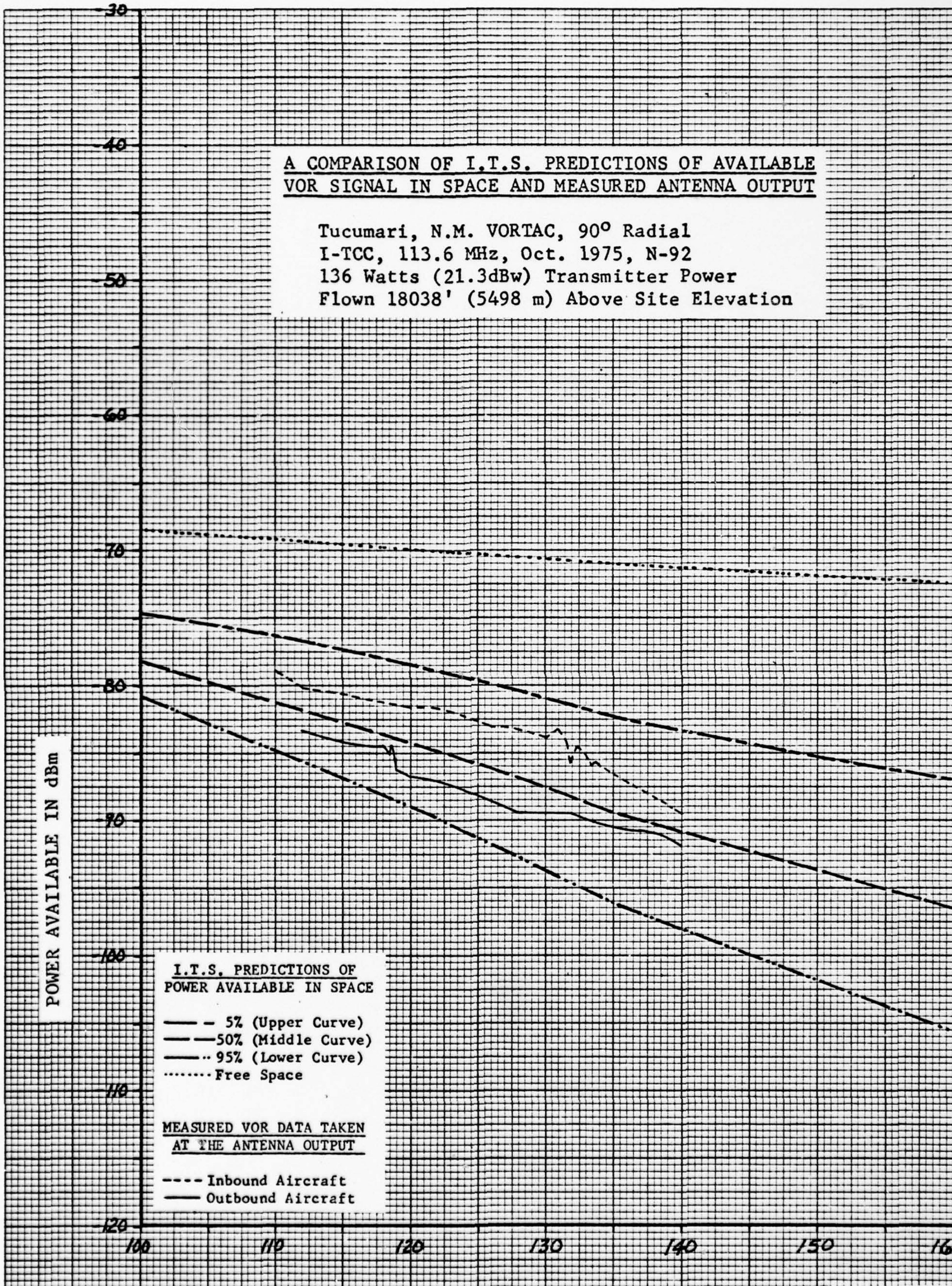

A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Truth Or Consequences, N.M. VORTAC, 360° RADIAL
I-TSC, 112.7 MHz, Oct. 1975, N-92
118 Watts (20.7dBw) Transmitter Power
Flown 17997' (5485 m) Above Site Elevation
POWER AVAILABLE IN dBm
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
MARK LOPEZ
Approved
J.L.PIERZGA
March
1977

FIGURE A 16



A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Tucumari, N.M. VORTAC, 90° Radial
I-TCC, 113.6 MHz, Oct. 1975, N-92
136 Watts (21.3dBw) Transmitter Power
Flown 18038' (5498 m) Above Site Elevation
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
R.D.SMITH
Approved
J.L.PIERZGA
March
1977

FIGURE A 17

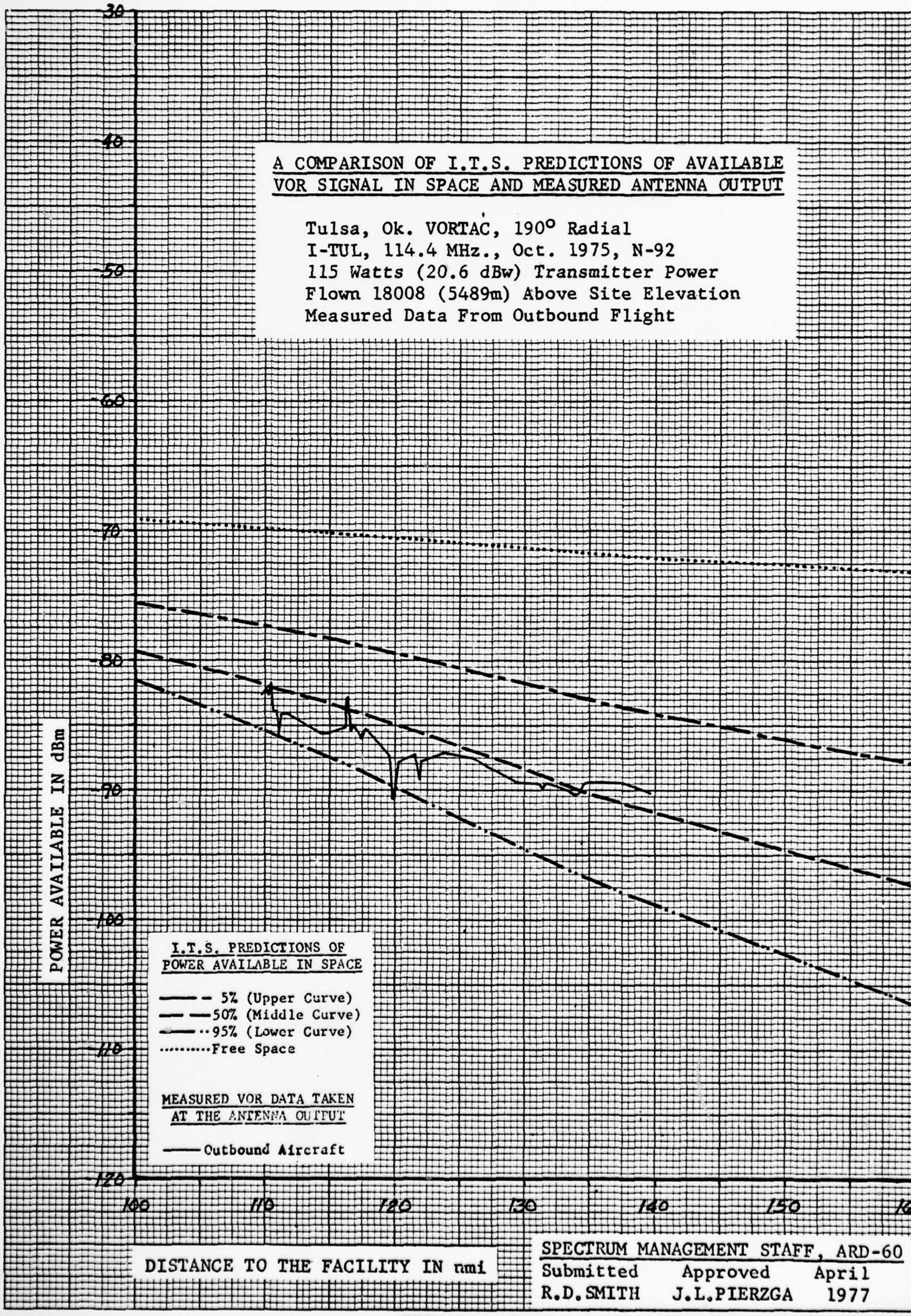

A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Tulsa, Ok. VORTAC, 190° Radial
I-TUL, 114.4 MHz., Oct. 1975, N-92
115 Watts (20.6 dBw) Transmitter Power
Flown 18008 (5489m) Above Site Elevation
Measured Data From Outbound Flight
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved April
R.D. SMITH J.L. PIERZGA 1977

FIGURE A 18

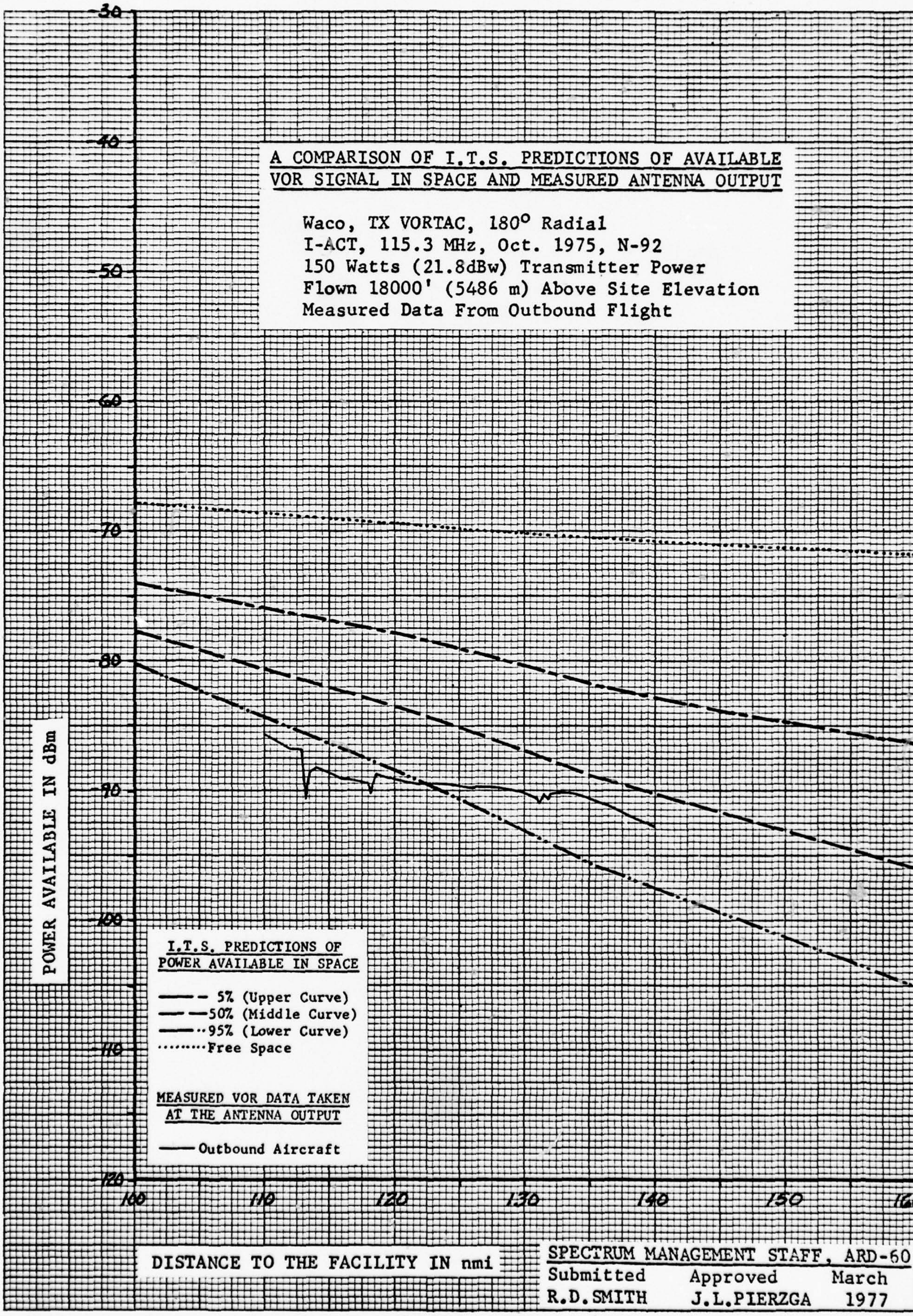

A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Waco, TX VORTAC, 180° Radial
I-ACT, 115.3 MHz, Oct. 1975, N-92
150 Watts (21.8dBw) Transmitter Power
Flown 18000' (5486 m) Above Site Elevation
Measured Data From Outbound Flight
POWER AVAILABLE IN dBm
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted R.D.SMITH
Approved J.L.PIERZGA
March 1977

FIGURE A 19

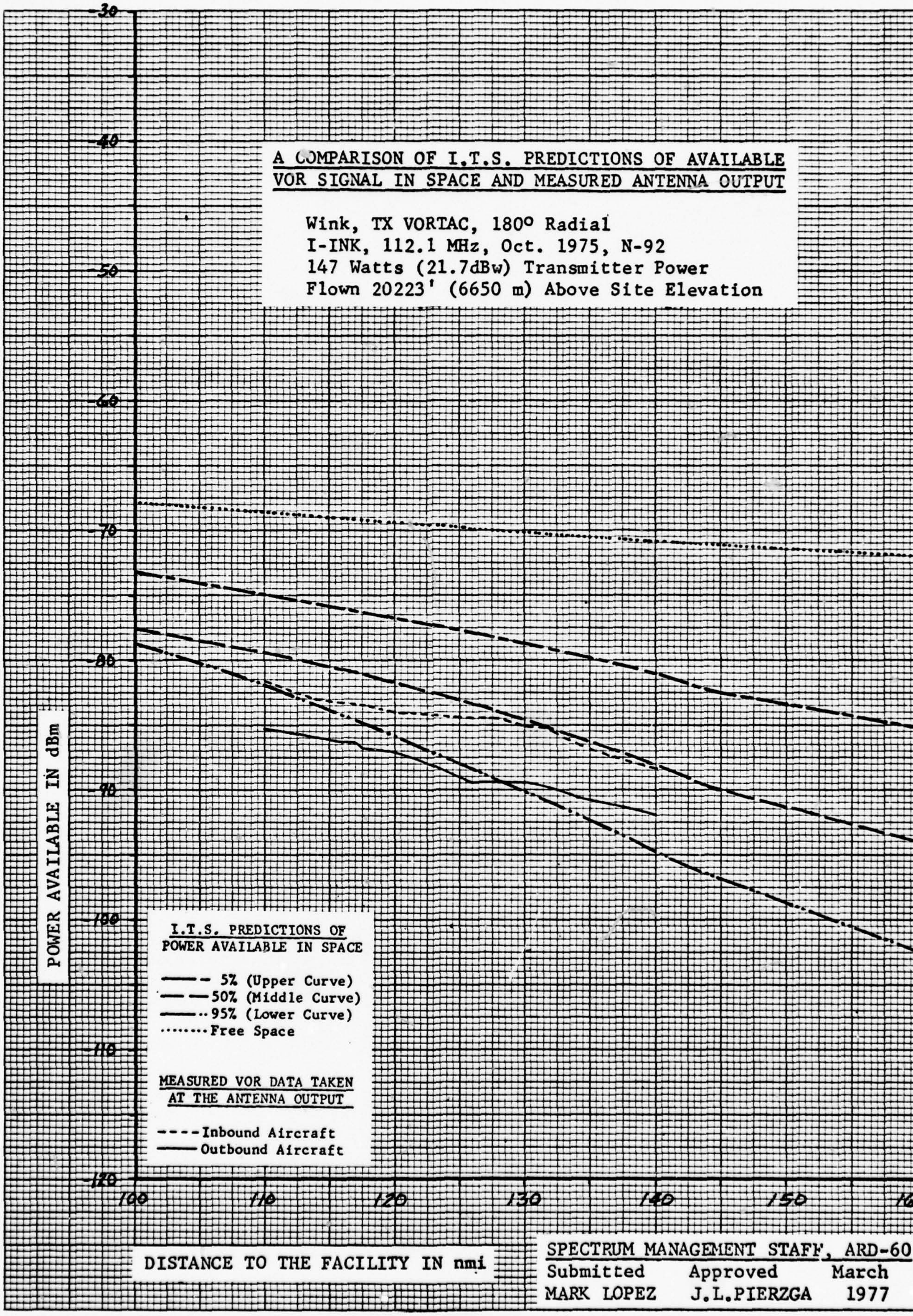

A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Wink, TX VORTAC, 180° Radial
I-INK, 112.1 MHz, Oct. 1975, N-92
147 Watts (21.7dBw) Transmitter Power
Flown 20223' (6650 m) Above Site Elevation
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
POWER AVAILABLE IN dBm
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted MARK LOPEZ
Approved J.L.PIERZGA
March 1977

FIGURE A 20

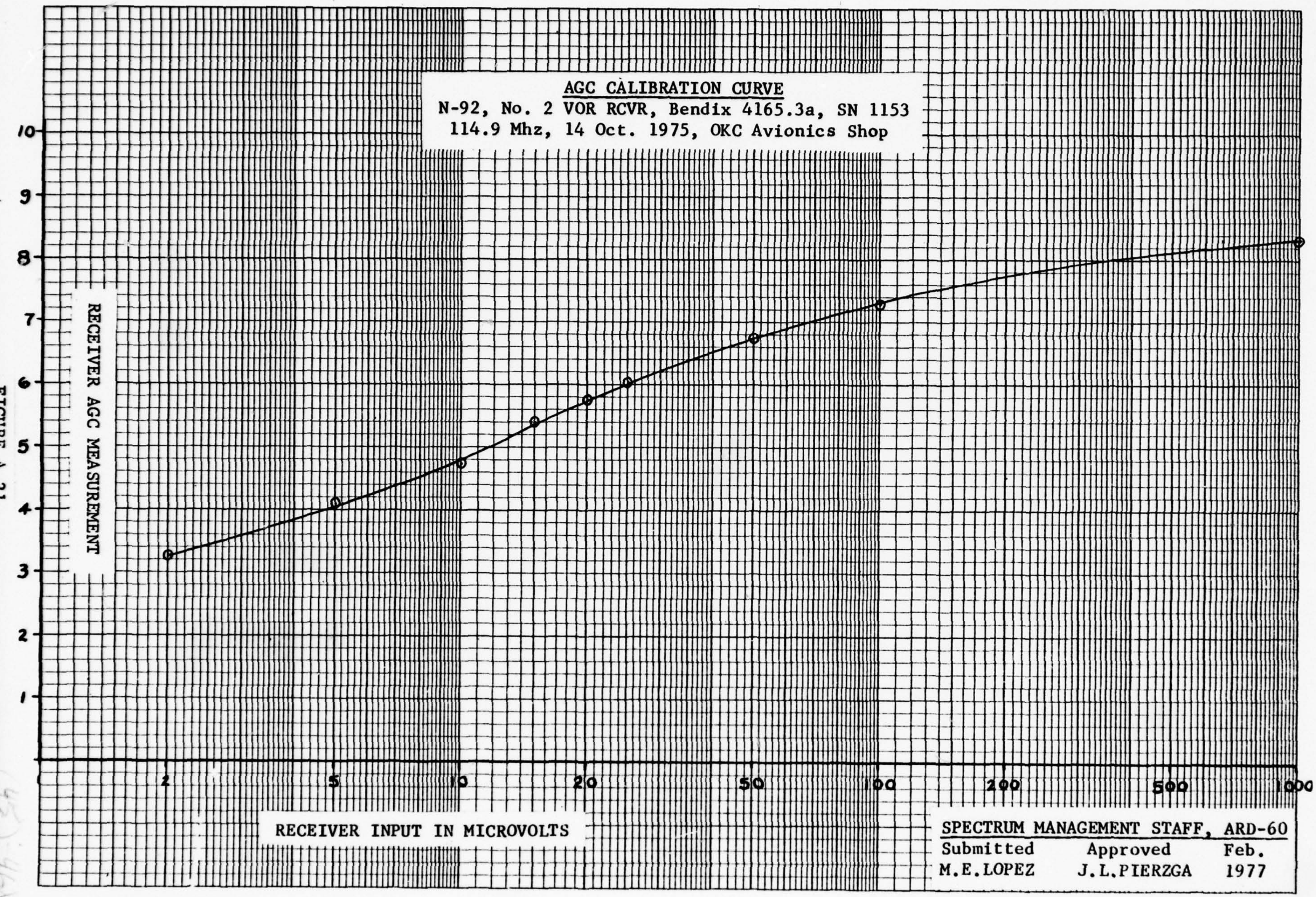


FIGURE A 21

(45) - 46X

APPENDIX B

MEASURED VOR RECEIVER INPUT

Appendix B shows the VOR data plotted in microvolts. The measured data has been adjusted in order to account for attenuation between the calibration point and the input to the VOR receiver. Consequently, the data shown here is 3.5 dB less than the raw measured data and 4.0 dB less than the adjusted data given in Appendix A.

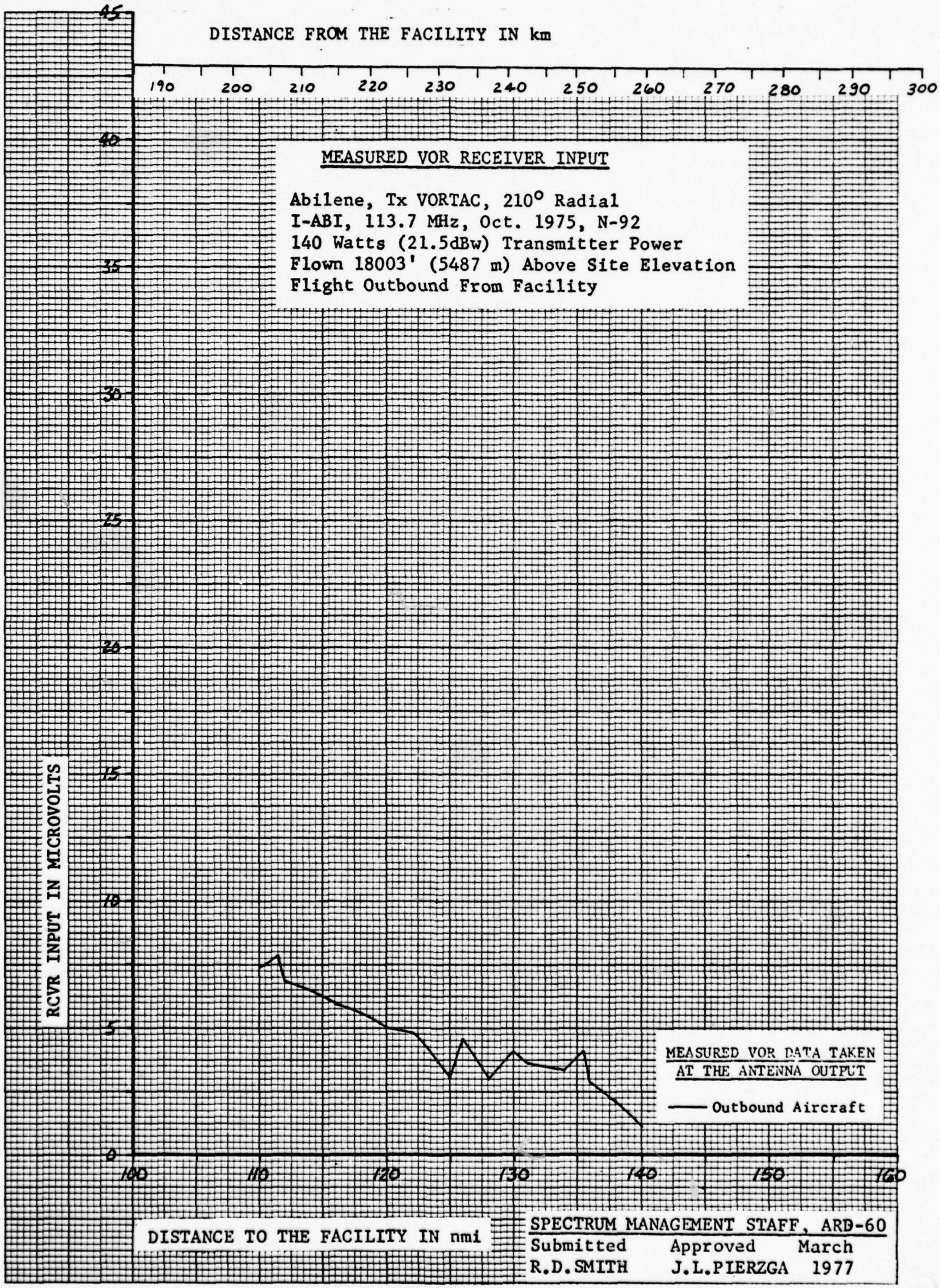

DISTANCE FROM THE FACILITY IN km
190 200 210 220 230 240 250 260 270 280 290 300
MEASURED VOR RECEIVER INPUT
Abilene, Tx VORTAC, 210° Radial
I-ABI, 113.7 MHz, Oct. 1975, N-92
140 Watts (21.5dBw) Transmitter Power
Flown 18003' (5487 m) Above Site Elevation
Flight Outbound From Facility
45 40 35 30 25 20 15 10 5 0
RCVR INPUT IN MICROVOLTS
MEASURED VOR DATA TAKEN
AT THE ANTENNA OUTPUT
Outbound Aircraft
100 110 120 130 140 150 160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved March
R.D.SMITH J.L.PIERZGA 1977

FIGURE B 1

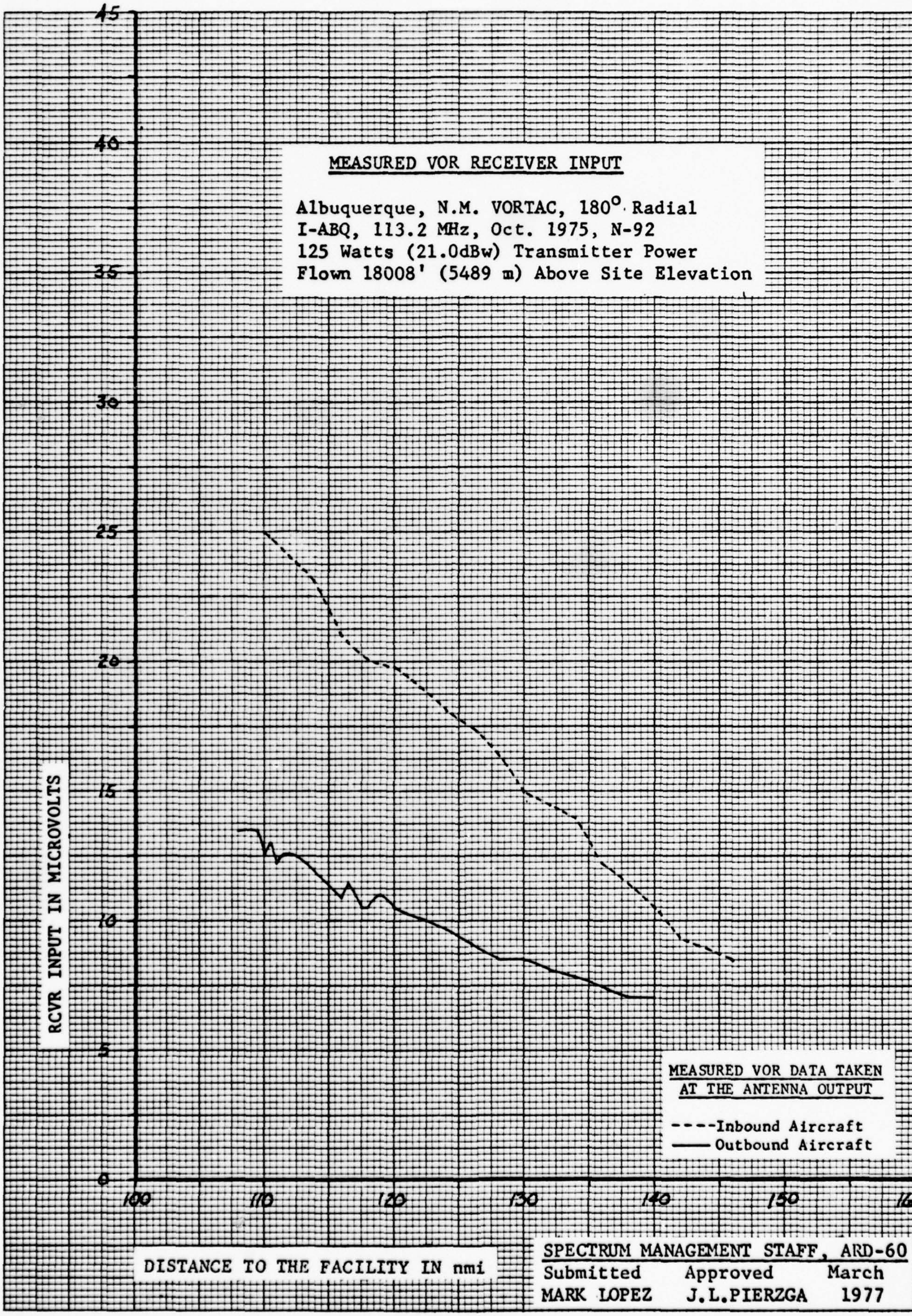
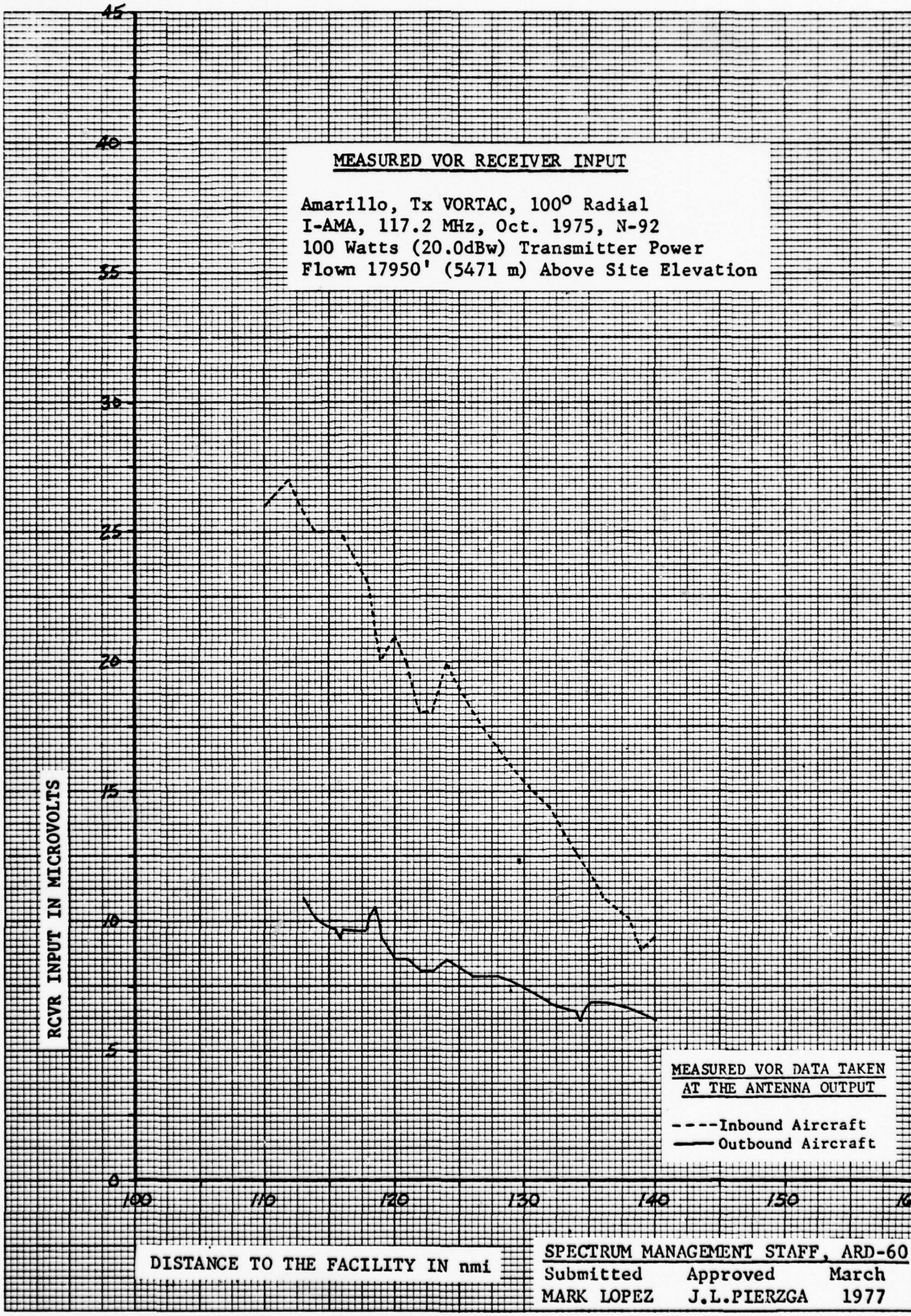

MEASURED VOR RECEIVER INPUT
Albuquerque, N.M. VORTAC, 180° Radial
I-ABQ, 113.2 MHz, Oct. 1975, N-92
125 Watts (21.0dBw) Transmitter Power
Flown 18008' (5489 m) Above Site Elevation
RCVR INPUT IN MICROVOLTS
0
5
10
15
20
25
30
35
40
45
100
110
120
130
140
150
160
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
----Inbound Aircraft
——Outbound Aircraft
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
MARK LOPEZ
Approved
J.L.PIERZGA
March
1977

FIGURE B 2



MEASURED VOR RECEIVER INPUT
Amarillo, Tx VORTAC, 100° Radial
I-AMA, 117.2 MHz, Oct. 1975, N-92
100 Watts (20.0dBw) Transmitter Power
Flown 17950' (5471 m) Above Site Elevation
45
40
35
30
25
20
15
10
5
0
RCVR INPUT IN MICROVOLTS
100
110
120
130
140
150
160
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
----Inbound Aircraft
——Outbound Aircraft
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved March
MARK LOPEZ J.L.PIERZGA 1977

FIGURE B 3

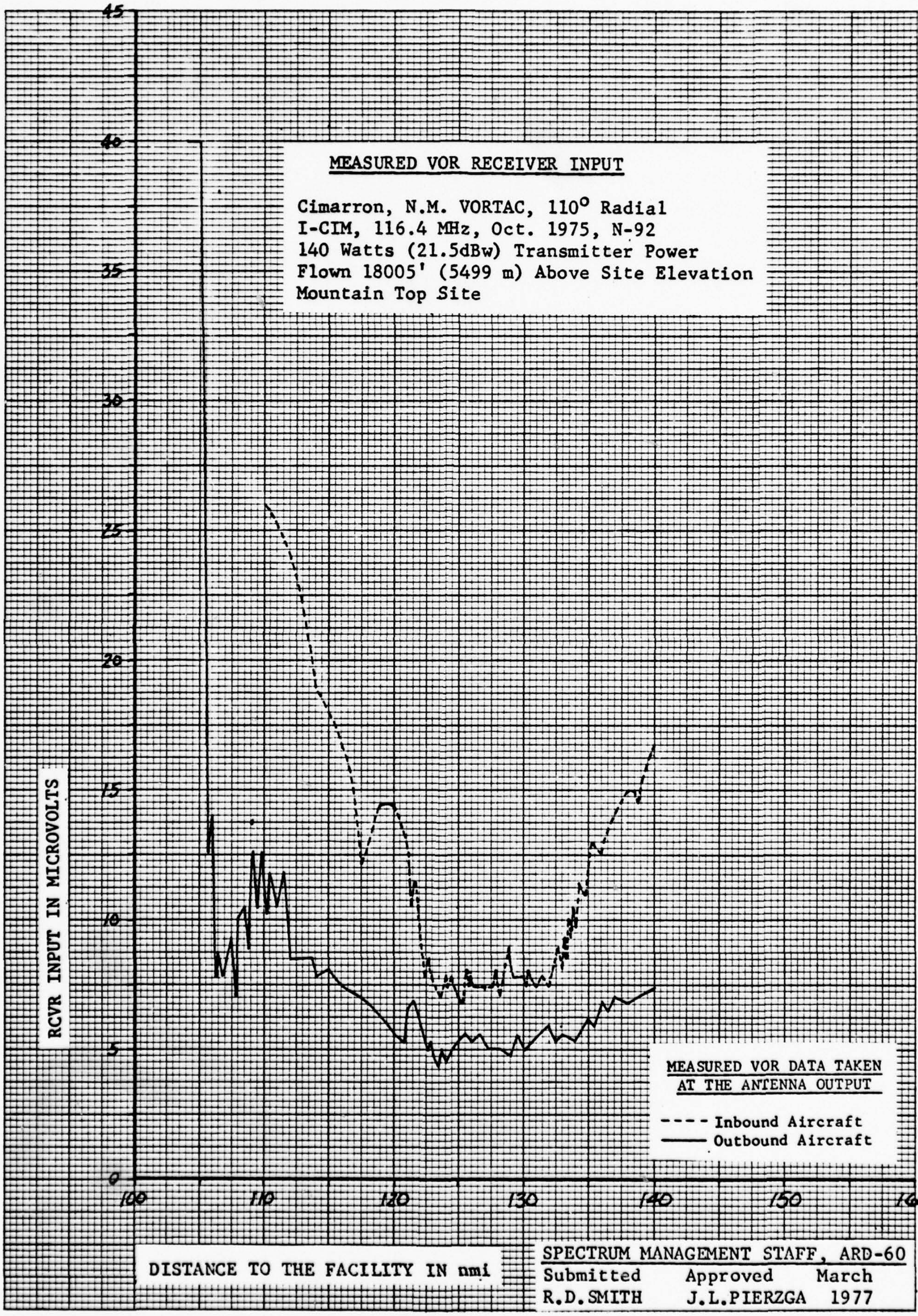
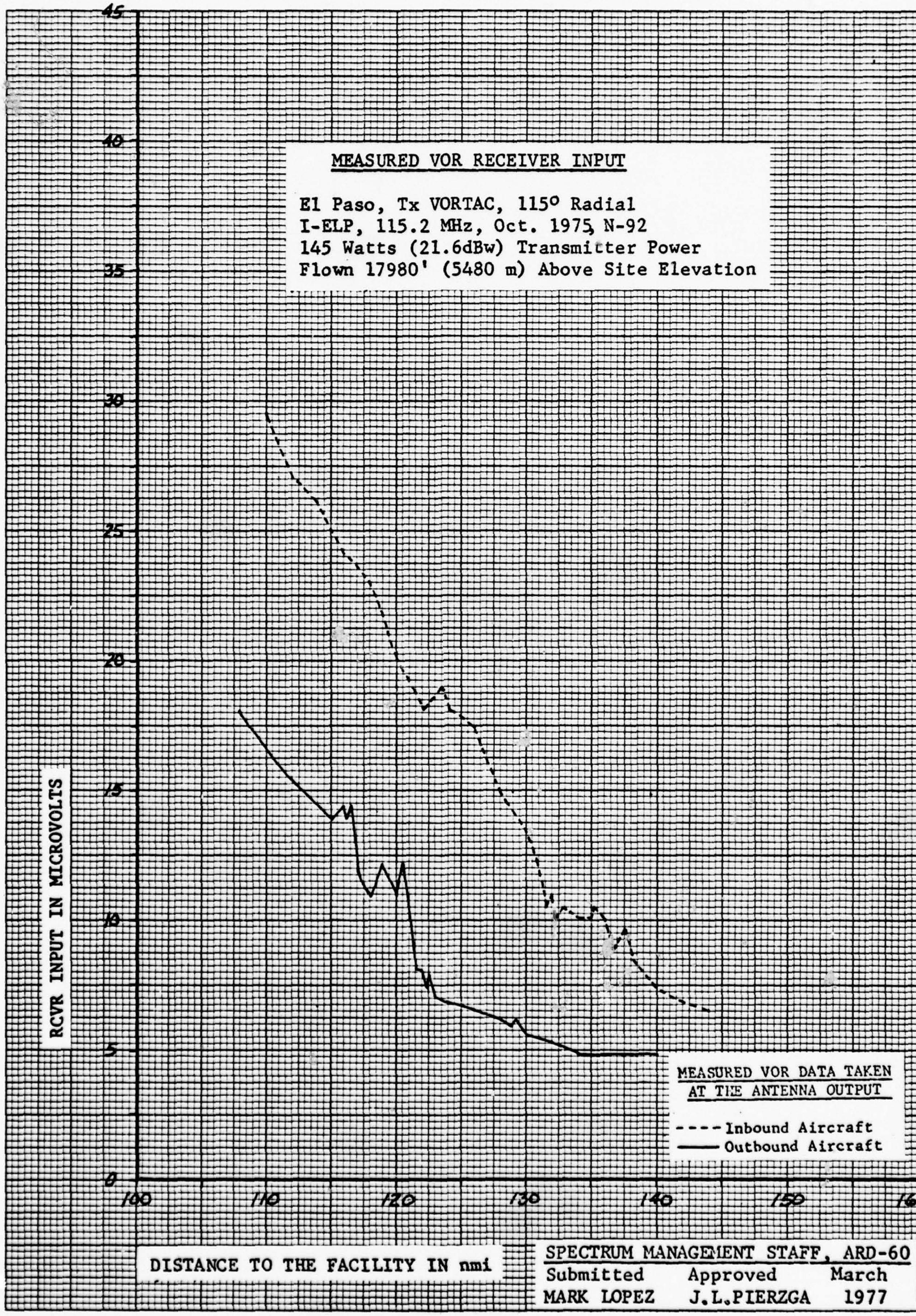

MEASURED VOR RECEIVER INPUT
Cimarron, N.M. VORTAC, 110° Radial
I-CIM, 116.4 MHz, Oct. 1975, N-92
140 Watts (21.5dBw) Transmitter Power
Flown 18005' (5499 m) Above Site Elevation
Mountain Top Site
RCVR INPUT IN MICROVOLTS
45
40
35
30
25
20
15
10
5
0
100
110
120
130
140
150
160
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved March
R.D.SMITH J.L.PIERZGA 1977

FIGURE B 4



MEASURED VOR RECEIVER INPUT
El Paso, Tx VORTAC, 115° Radial
I-ELP, 115.2 MHz, Oct. 1975, N-92
145 Watts (21.6dBw) Transmitter Power
Flown 17980' (5480 m) Above Site Elevation
RCVR INPUT IN MICROVOLTS
45
40
35
30
25
20
15
10
5
0
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved March
MARK LOPEZ J.L.PIERZGA 1977

FIGURE B 5

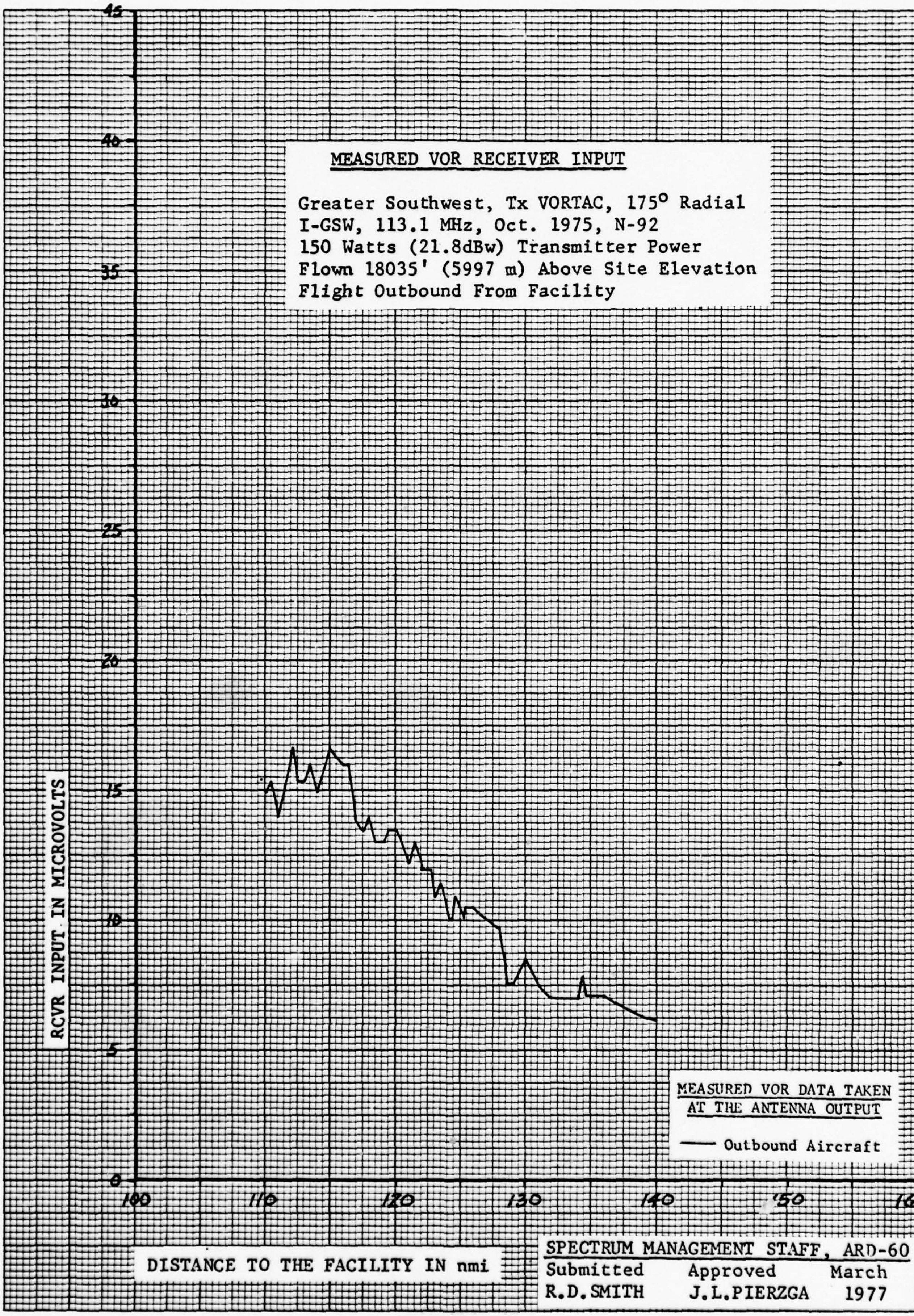

MEASURED VOR RECEIVER INPUT
Greater Southwest, Tx VORTAC, 175° Radial
I-GSW, 113.1 MHz, Oct. 1975, N-92
150 Watts (21.8dBw) Transmitter Power
Flown 18035' (5997 m) Above Site Elevation
Flight Outbound From Facility
RCVR INPUT IN MICROVOLTS
45
40
35
30
25
20
15
10
5
0
100
110
120
130
140
150
160
MEASURED VOR DATA TAKEN
AT THE ANTENNA OUTPUT
Outbound Aircraft
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
Approved
March
R.D.SMITH
J.L.PIERZGA
1977

FIGURE B 6

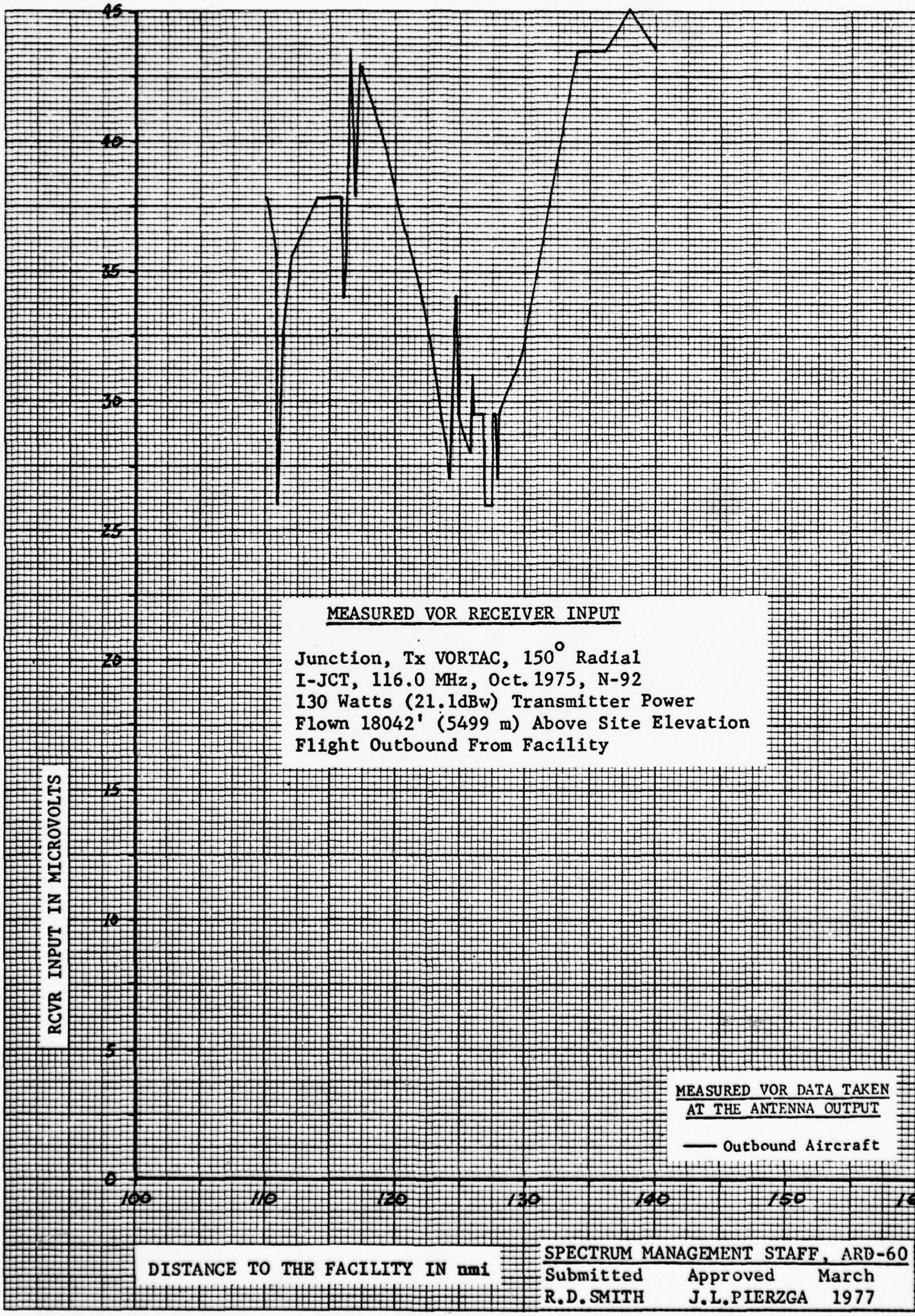

MEASURED VOR RECEIVER INPUT
Junction, Tx VORTAC, 150° Radial
I-JCT, 116.0 MHz, Oct. 1975, N-92
130 Watts (21.1dBw) Transmitter Power
Flown 18042' (5499 m) Above Site Elevation
Flight Outbound From Facility
RCVR INPUT IN MICROVOLTS
45
40
35
30
25
20
15
10
5
0
100
110
120
130
140
150
160
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted R.D. SMITH
Approved J.L. PIERZGA
March 1977

FIGURE B 7

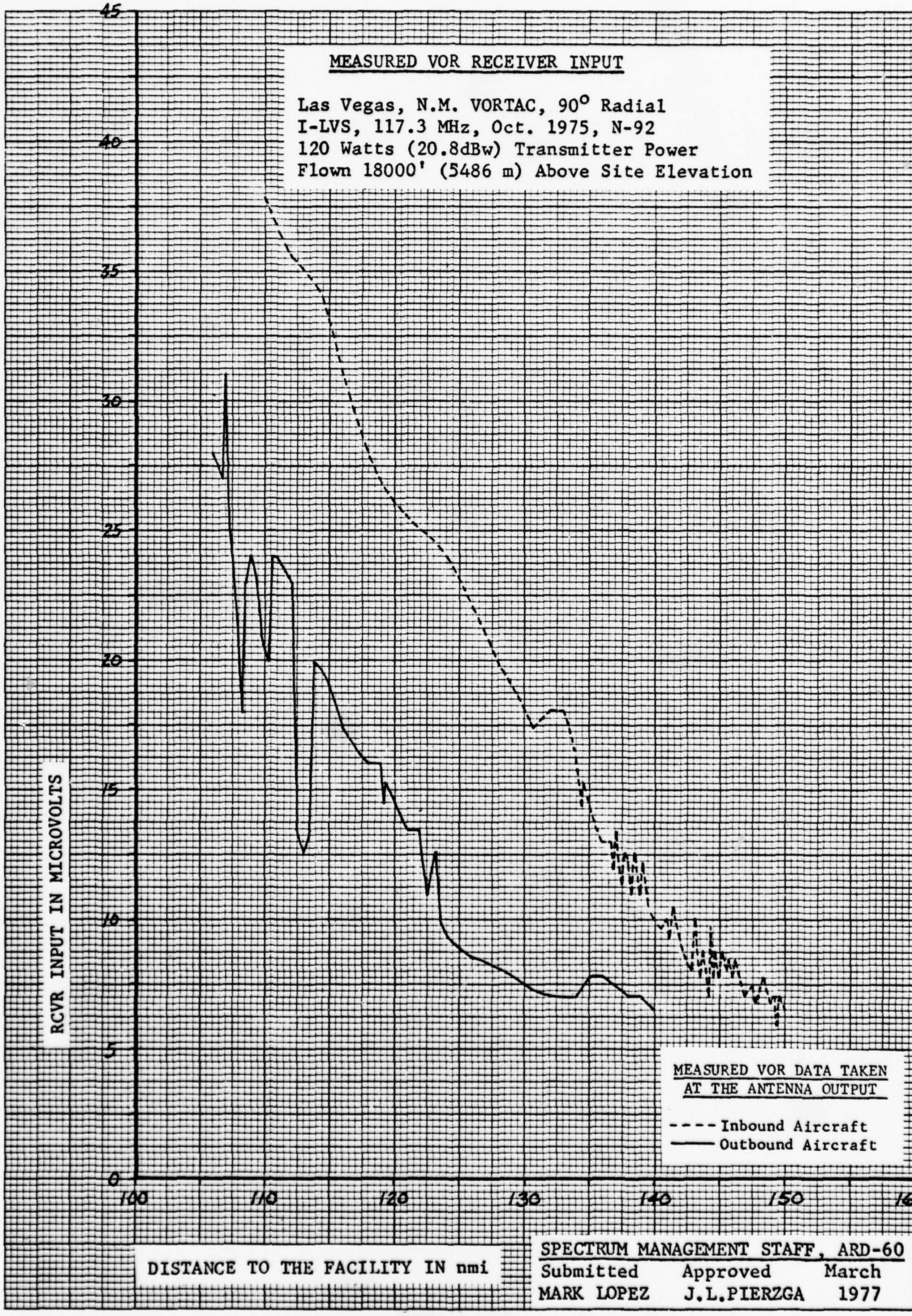
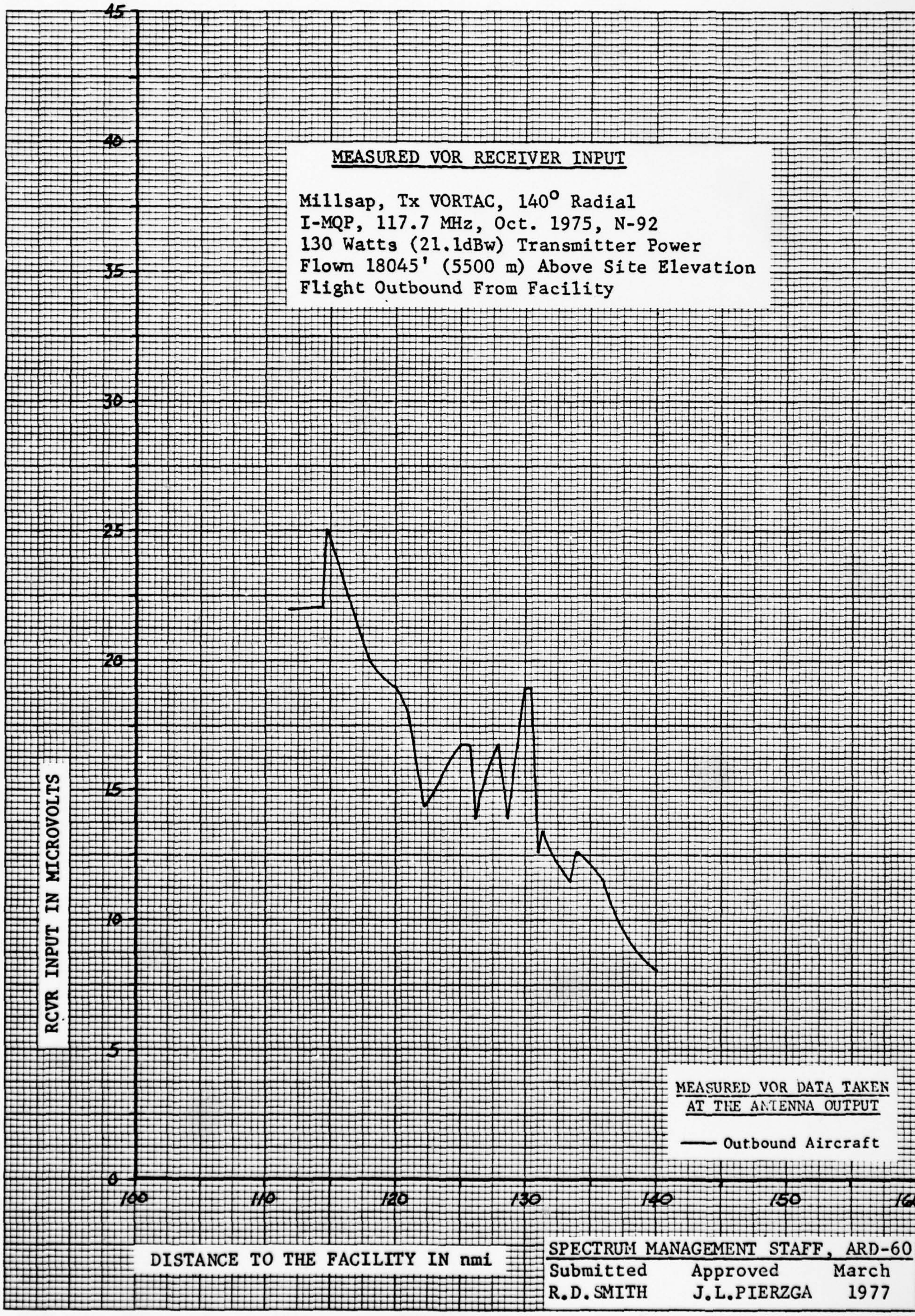

MEASURED VOR RECEIVER INPUT
Las Vegas, N.M. VORTAC, 90° Radial
I-LVS, 117.3 MHz, Oct. 1975, N-92
120 Watts (20.8dBw) Transmitter Power
Flown 18000' (5486 m) Above Site Elevation
45
40
35
30
25
20
15
10
5
0
RCVR INPUT IN MICROVOLTS
100
110
120
130
140
150
160
MEASURED VOR DATA TAKEN
AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved March
MARK LOPEZ J.L.PIERZGA 1977

FIGURE B 8



MEASURED VOR RECEIVER INPUT
Millsap, Tx VORTAC, 140° Radial
I-MQP, 117.7 MHz, Oct. 1975, N-92
130 Watts (21.1dBw) Transmitter Power
Flown 18045' (5500 m) Above Site Elevation
Flight Outbound From Facility
RCVR INPUT IN MICROVOLTS
45
40
35
30
25
20
15
10
5
0
100
110
120
130
140
150
160
MEASURED VOR DATA TAKEN
AT THE ANTENNA OUTPUT
Outbound Aircraft
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
R.D.SMITH
Approved
J.L.PIERZGA
March
1977

FIGURE B 9

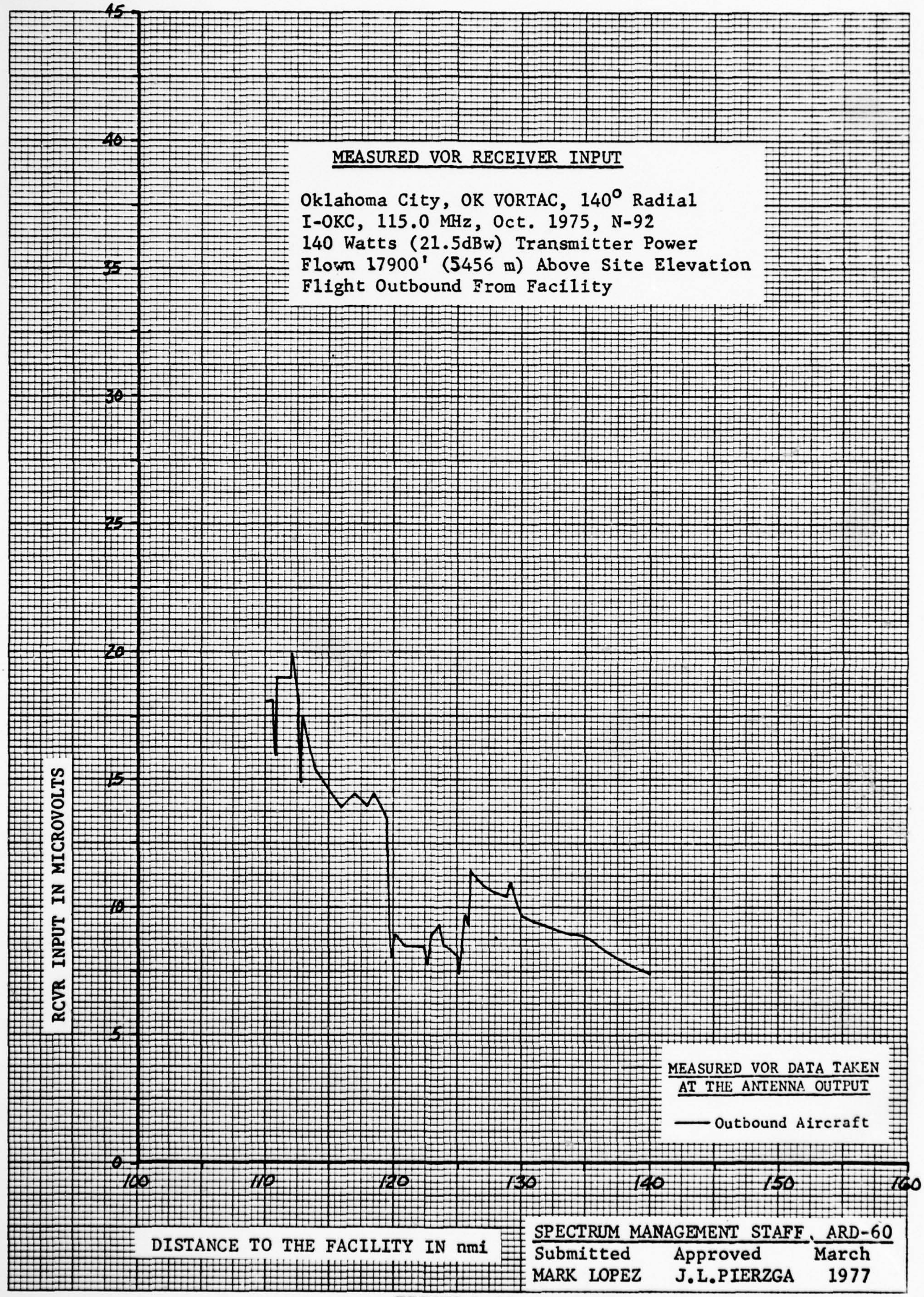

MEASURED VOR RECEIVER INPUT
Oklahoma City, OK VORTAC, 140° Radial
I-OKC, 115.0 MHz, Oct. 1975, N-92
140 Watts (21.5dBw) Transmitter Power
Flown 17900' (5456 m) Above Site Elevation
Flight Outbound From Facility
RCVR INPUT IN MICROVOLTS
45
40
35
30
25
20
15
10
5
0
100
110
120
130
140
150
160
MEASURED VOR DATA TAKEN
AT THE ANTENNA OUTPUT
Outbound Aircraft
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved March
MARK LOPEZ J.L.PIERZGA 1977

FIGURE B 10

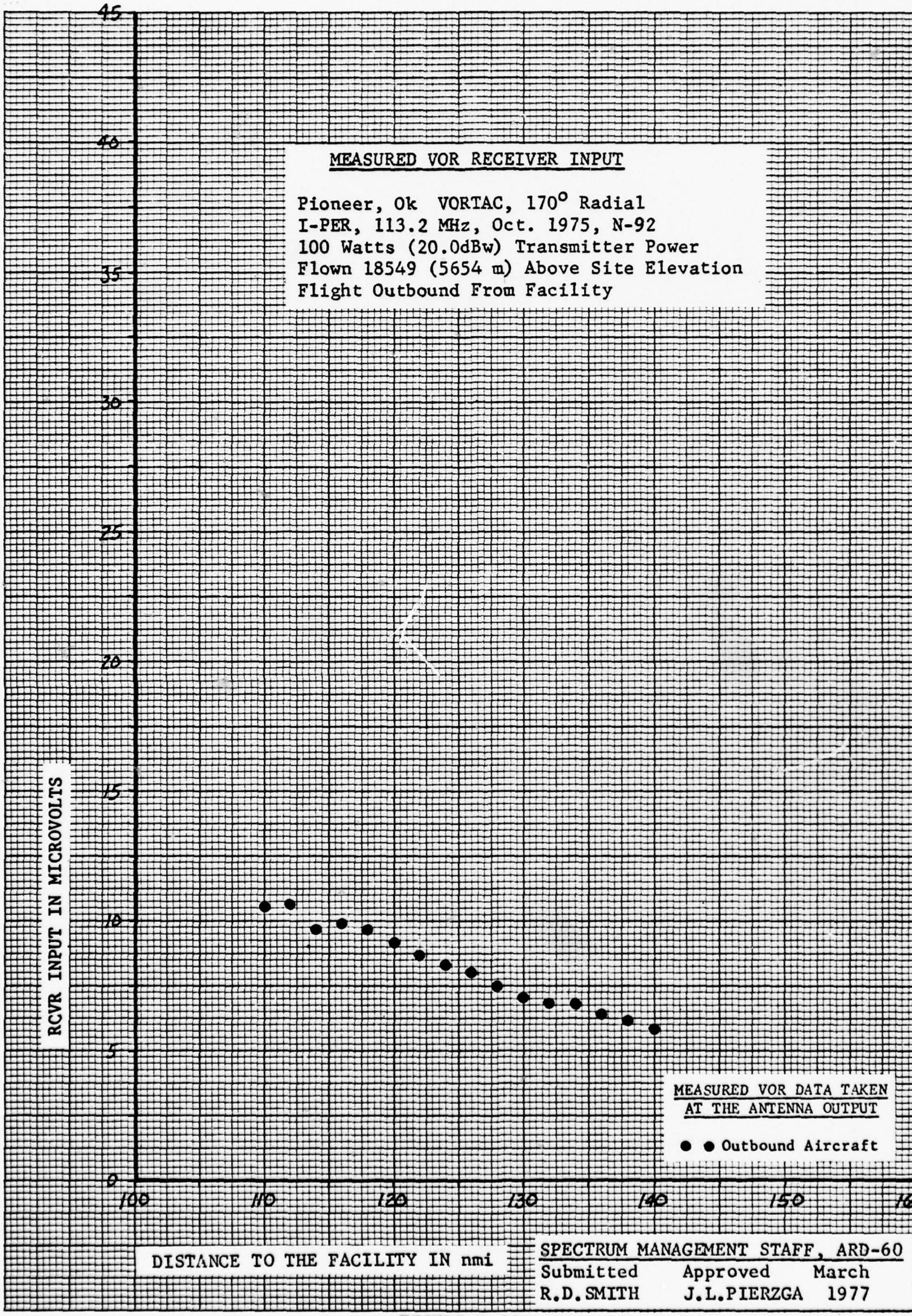
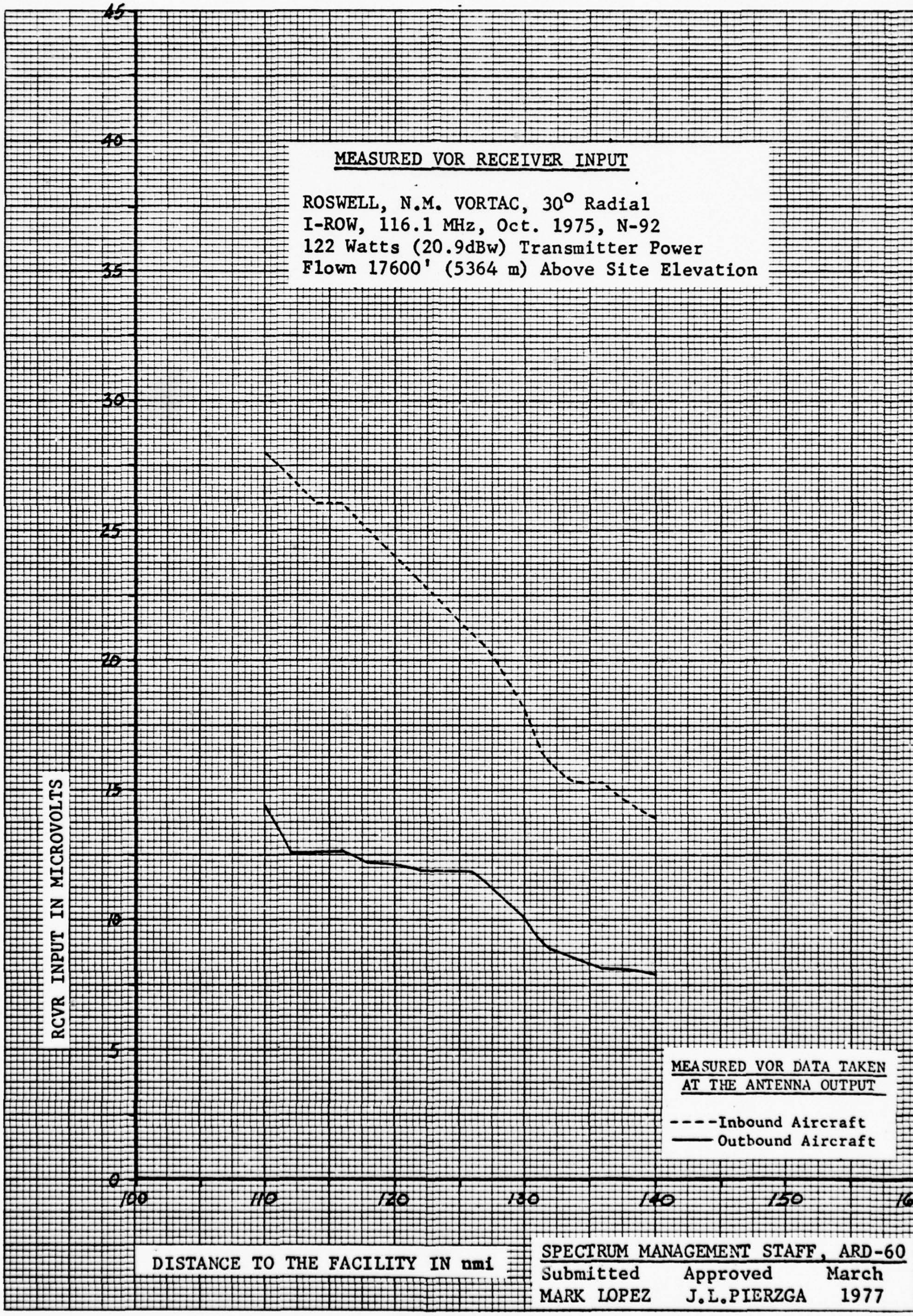

MEASURED VOR RECEIVER INPUT
Pioneer, Ok VORTAC, 170° Radial
I-PER, 113.2 MHz, Oct. 1975, N-92
100 Watts (20.0dBw) Transmitter Power
Flown 18549 (5654 m) Above Site Elevation
Flight Outbound From Facility
RCVR INPUT IN MICROVOLTS
45
40
35
30
25
20
15
10
5
0
100
110
120
130
140
150
160
MEASURED VOR DATA TAKEN
AT THE ANTENNA OUTPUT
● ● Outbound Aircraft
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted R.D.SMITH
Approved J.L.PIERZGA
March 1977

FIGURE B 11



MEASURED VOR RECEIVER INPUT
ROSWELL, N.M. VORTAC, 30° Radial
I-ROW, 116.1 MHz, Oct. 1975, N-92
122 Watts (20.9dBw) Transmitter Power
Flown 17600' (5364 m) Above Site Elevation
RCVR INPUT IN MICROVOLTS
45
40
35
30
25
20
15
10
5
0
100
110
120
130
140
150
160
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
----Inbound Aircraft
——Outbound Aircraft
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
MARK LOPEZ
Approved
J.L.PIERZGA
March
1977

FIGURE B 12

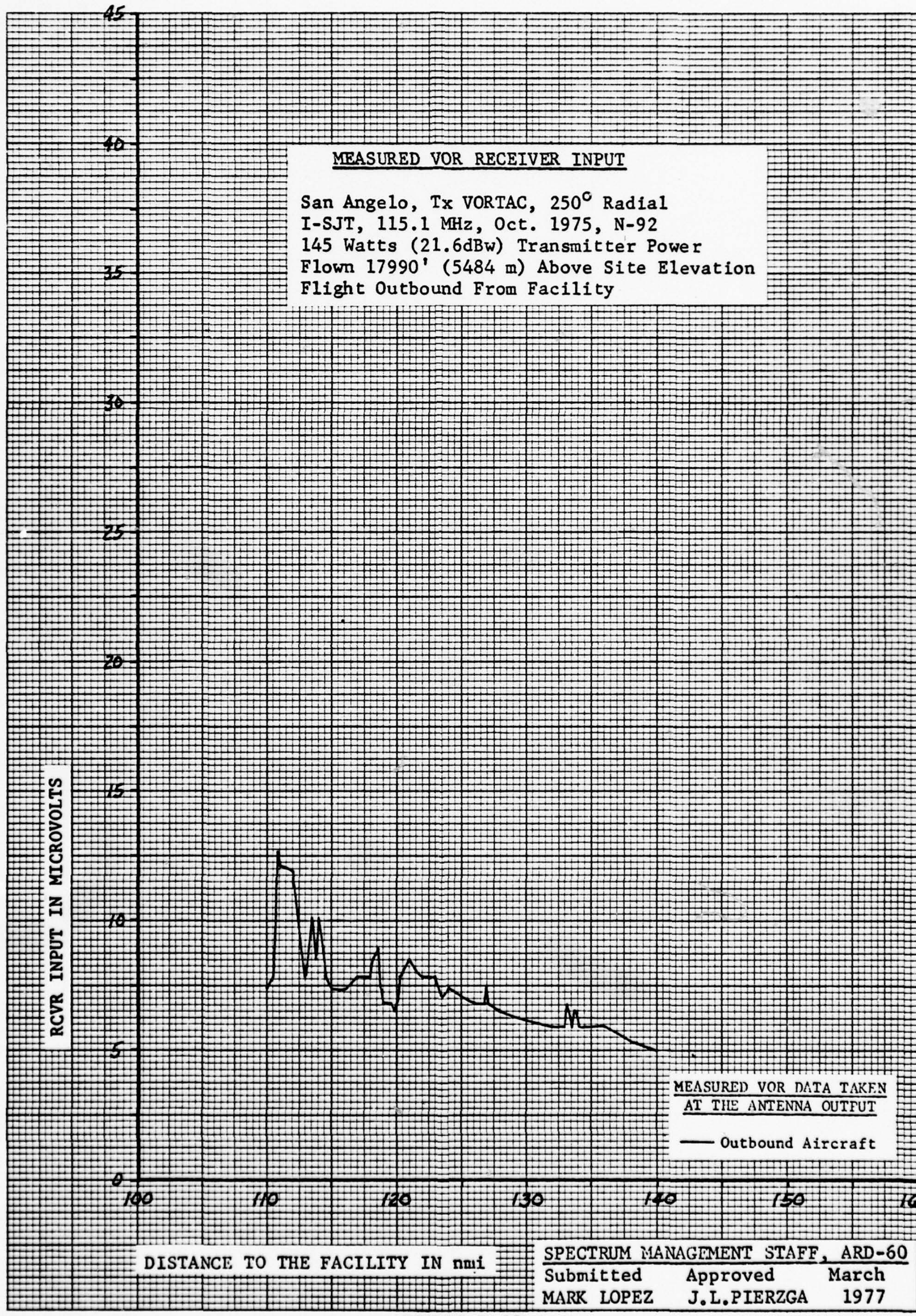

MEASURED VOR RECEIVER INPUT
San Angelo, Tx VORTAC, 250° Radial
I-SJT, 115.1 MHz, Oct. 1975, N-92
145 Watts (21.6dBw) Transmitter Power
Flown 17990' (5484 m) Above Site Elevation
Flight Outbound From Facility
RCVR INPUT IN MICROVOLTS
45
40
35
30
25
20
15
10
5
0
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
MARK LOPEZ
Approved
J.L.PIERZGA
March
1977

FIGURE B 13

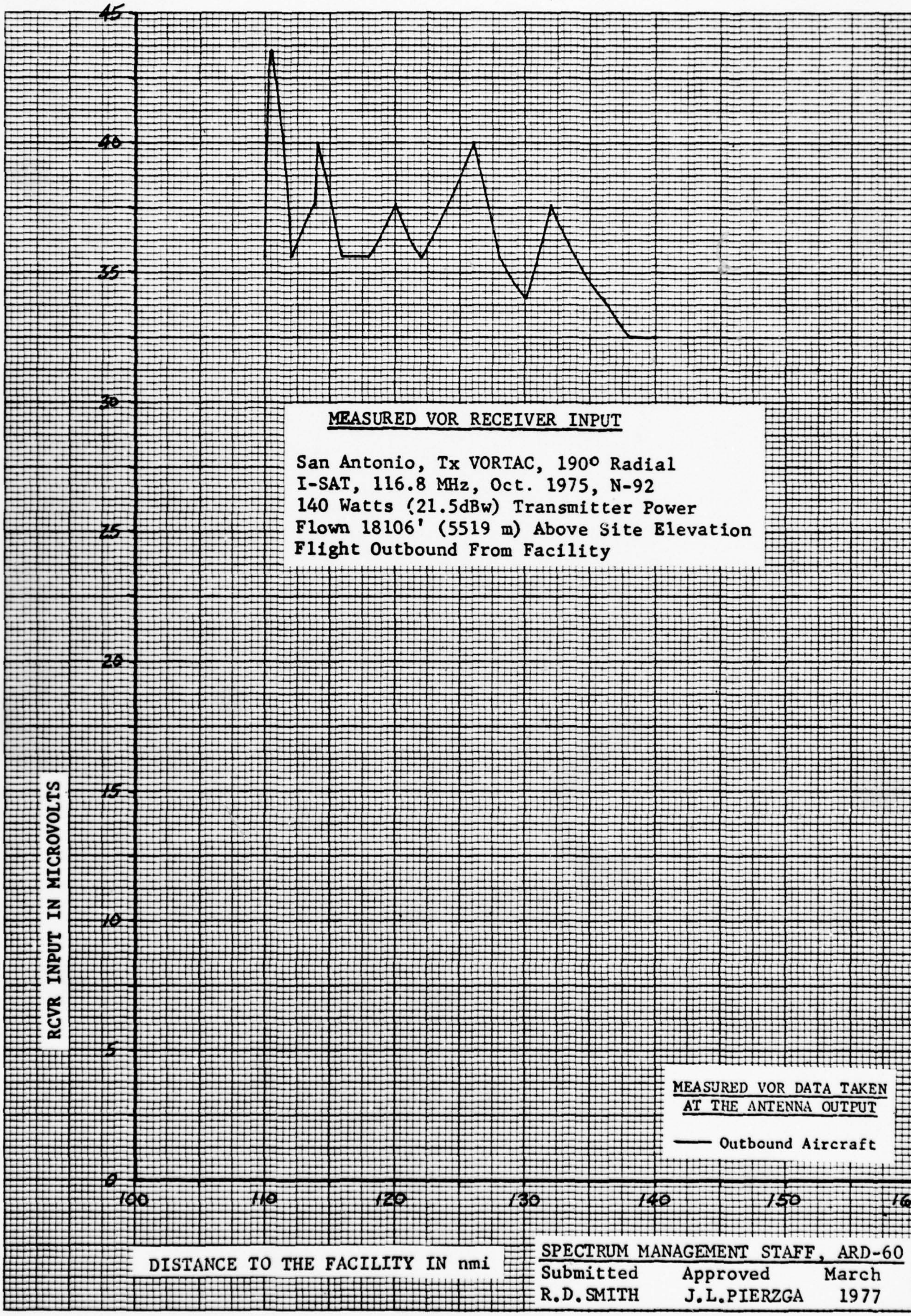
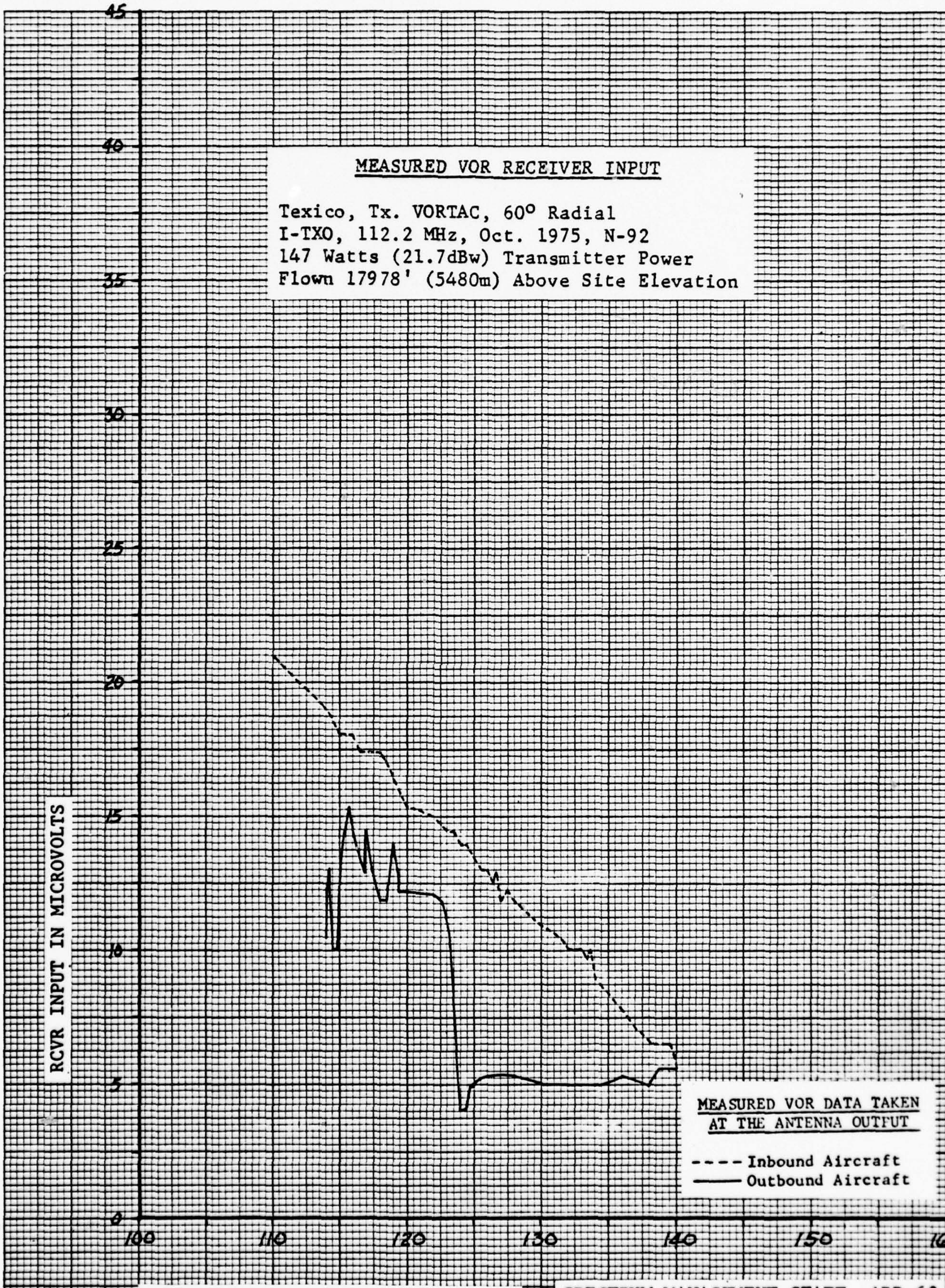

MEASURED VOR RECEIVER INPUT
San Antonio, Tx VORTAC, 190° Radial
I-SAT, 116.8 MHz, Oct. 1975, N-92
140 Watts (21.5dBw) Transmitter Power
Flown 18106' (5519 m) Above Site Elevation
Flight Outbound From Facility
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
RCVR INPUT IN MICROVOLTS
0
5
10
15
20
25
30
35
40
45
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
Approved
March
R.D.SMITH
J.L.PIERZGA
1977

FIGURE B 14



MEASURED VOR RECEIVER INPUT
Texico, Tx. VORTAC, 60° Radial
I-TXO, 112.2 MHz, Oct. 1975, N-92
147 Watts (21.7dBw) Transmitter Power
Flown 17978' (5480m) Above Site Elevation
RCVR INPUT IN MICROVOLTS
0
5
10
15
20
25
30
35
40
45
100
110
120
130
140
150
160
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted R.D.SMITH
Approved J.L.PIERZGA
March 1977

FIGURE B 15

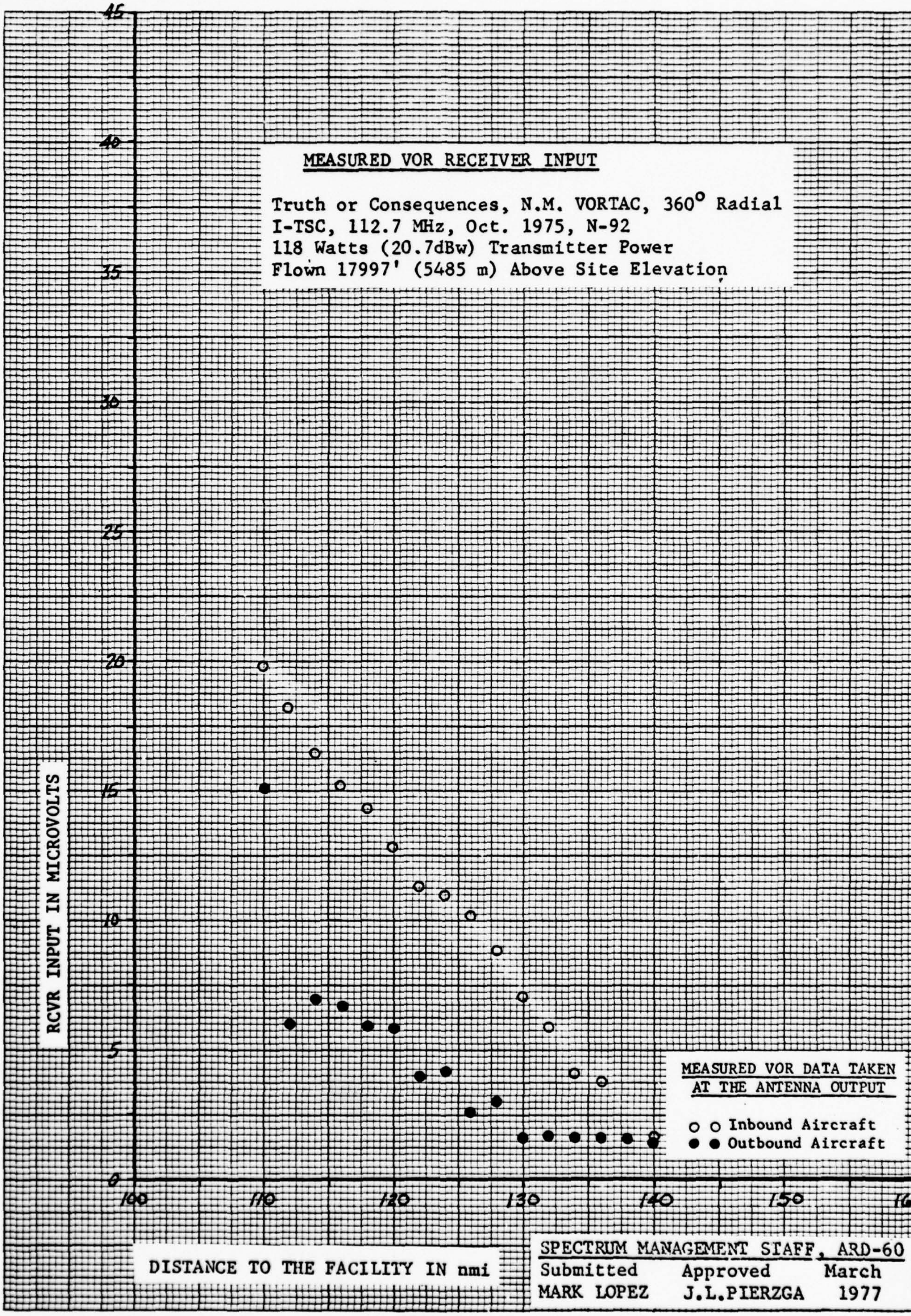
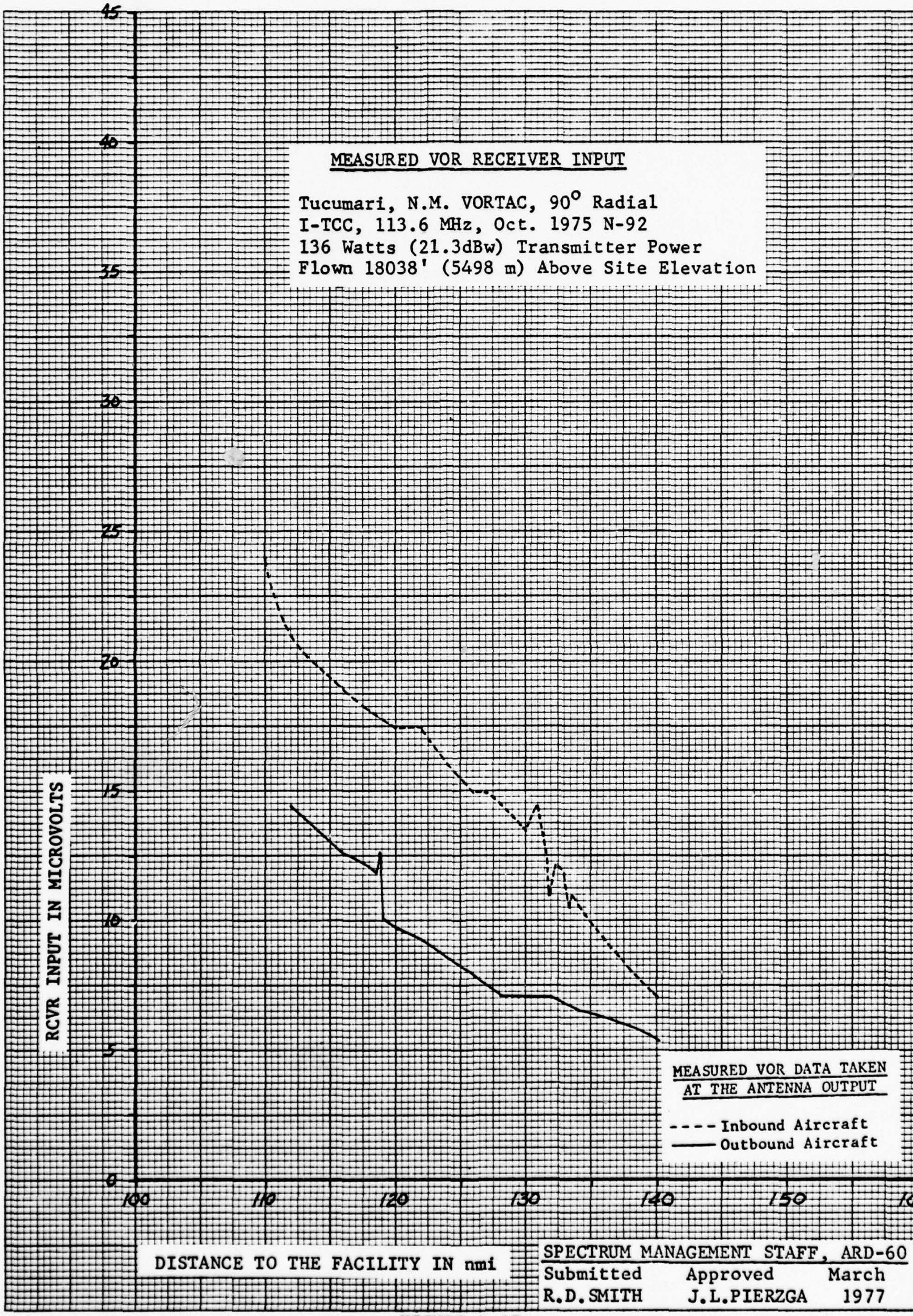
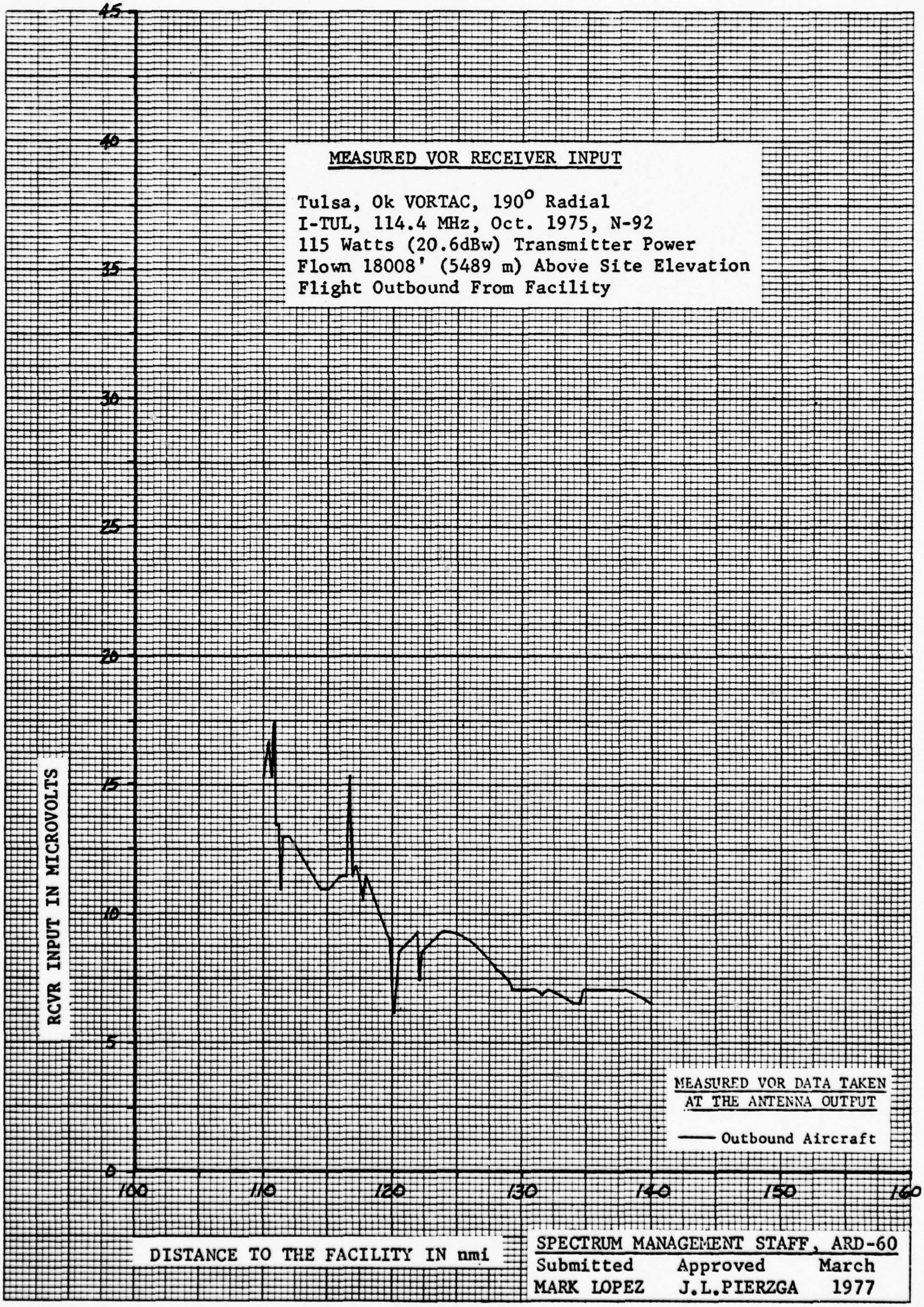

MEASURED VOR RECEIVER INPUT
Truth or Consequences, N.M. VORTAC, 360° Radial
I-TSC, 112.7 MHz, Oct. 1975, N-92
118 Watts (20.7dBw) Transmitter Power
Flown 17997' (5485 m) Above Site Elevation
RCVR INPUT IN MICROVOLTS
45
40
35
30
25
20
15
10
5
0
100
110
120
130
140
150
160
MEASURED VOR DATA TAKEN
AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
MARK LOPEZ
Approved
J.L.PIERZGA
March
1977

FIGURE B 16



MEASURED VOR RECEIVER INPUT
Tucumari, N.M. VORTAC, 90° Radial
I-TCC, 113.6 MHz, Oct. 1975 N-92
136 Watts (21.3dBw) Transmitter Power
Flown 18038' (5498 m) Above Site Elevation
RCVR INPUT IN MICROVOLTS
45
40
35
30
25
20
15
10
5
0
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted R.D.SMITH
Approved J.L.PIERZGA
March 1977

FIGURE B 17



MEASURED VOR RECEIVER INPUT
Tulsa, Ok VORTAC, 190° Radial
I-TUL, 114.4 MHz, Oct. 1975, N-92
115 Watts (20.6dBw) Transmitter Power
Flown 18008' (5489 m) Above Site Elevation
Flight Outbound From Facility
RCVR INPUT IN MICROVOLTS
45
40
35
30
25
20
15
10
5
0
100
110
120
130
140
150
160
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved March
MARK LOPEZ J.L.PIERZGA 1977

FIGURE B 18

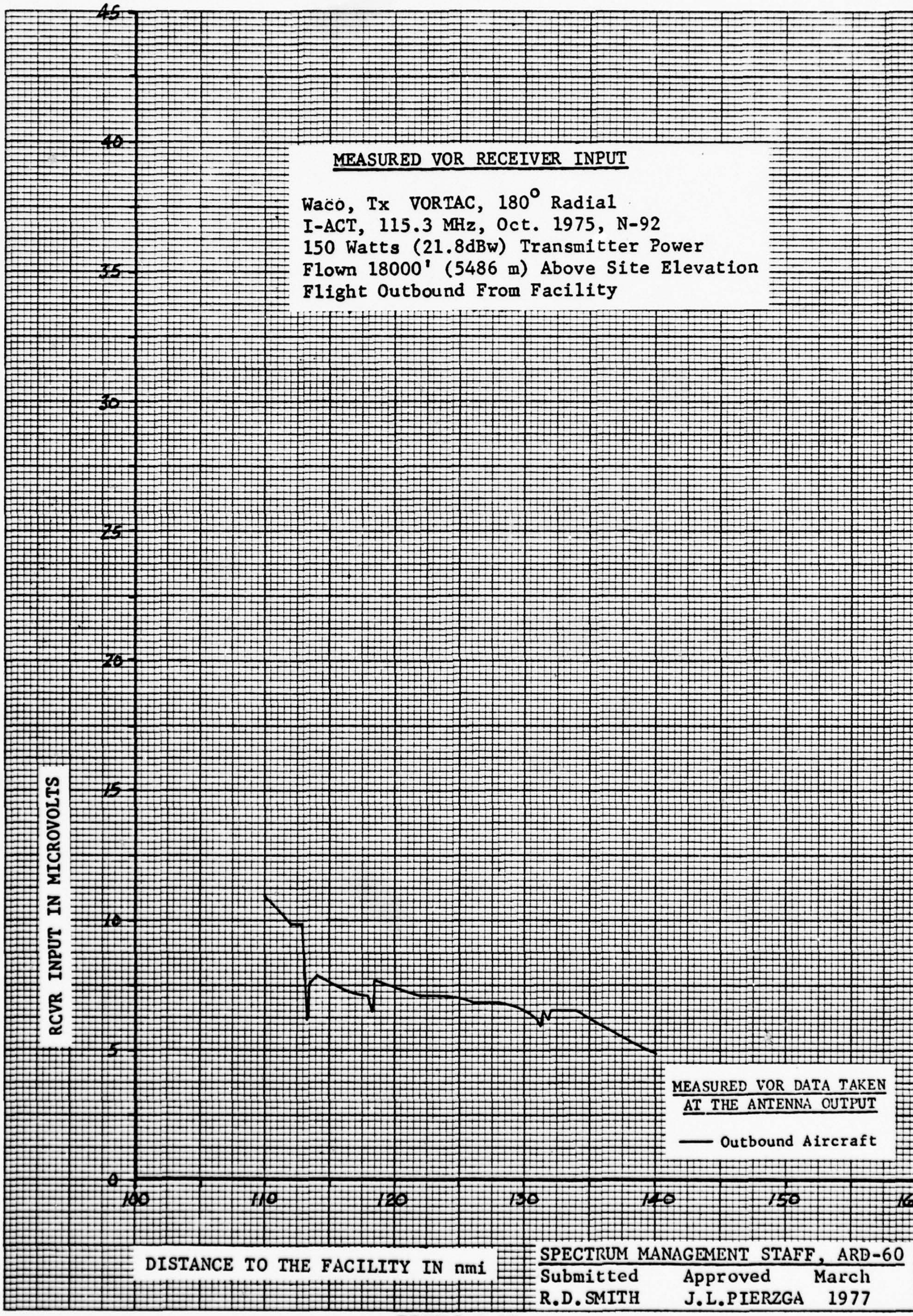

MEASURED VOR RECEIVER INPUT
Waco, Tx VORTAC, 180° Radial
I-ACT, 115.3 MHz, Oct. 1975, N-92
150 Watts (21.8dBw) Transmitter Power
Flown 18000' (5486 m) Above Site Elevation
Flight Outbound From Facility
RCVR INPUT IN MICROVOLTS
45
40
35
30
25
20
15
10
5
0
100
110
120
130
140
150
160
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved March
R.D.SMITH J.L.PIERZGA 1977

FIGURE B 19

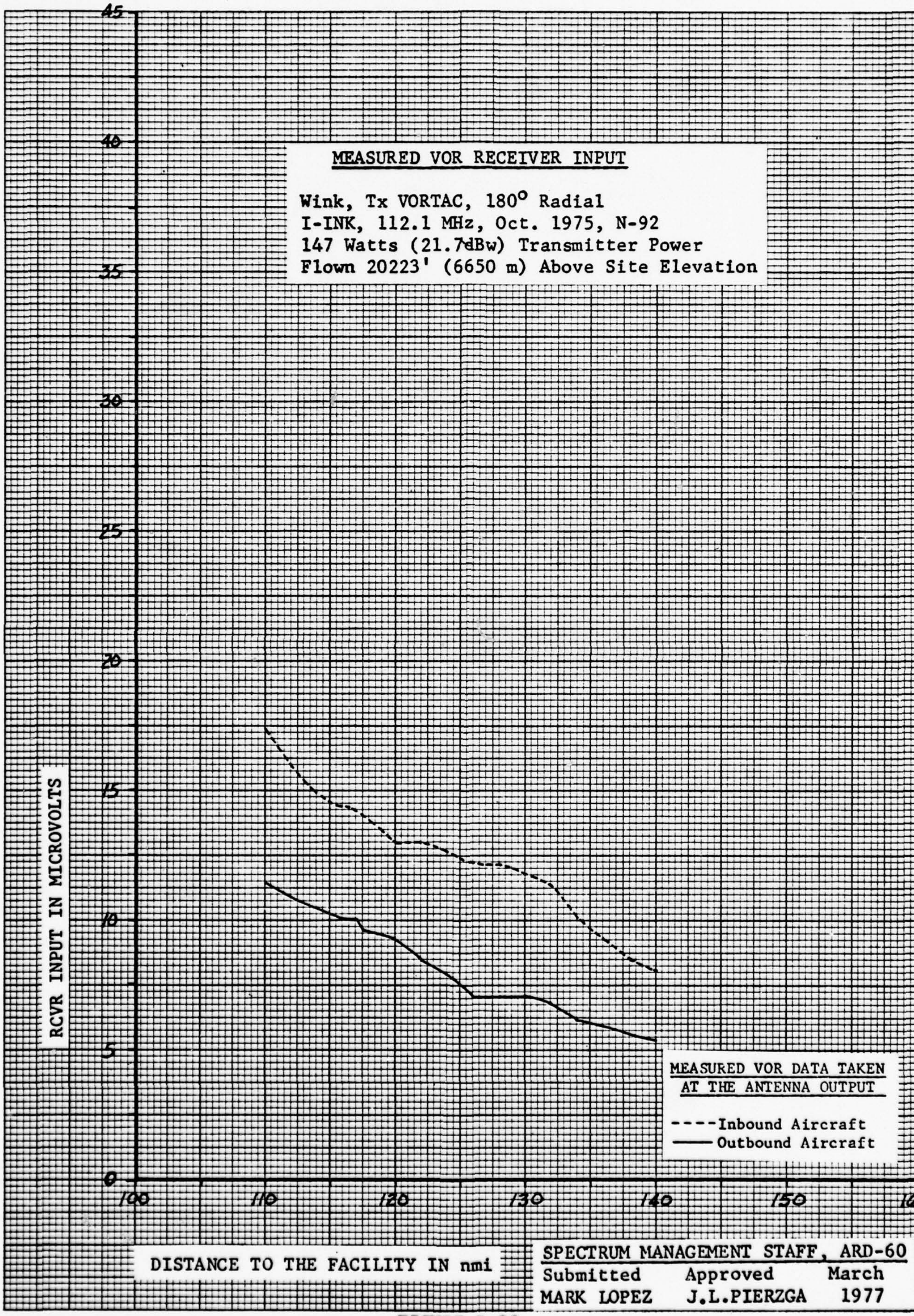

MEASURED VOR RECEIVER INPUT
Wink, Tx VORTAC, 180° Radial
I-INK, 112.1 MHz, Oct. 1975, N-92
147 Watts (21.7dBw) Transmitter Power
Flown 20223' (6650 m) Above Site Elevation
RCVR INPUT IN MICROVOLTS
45
40
35
30
25
20
15
10
5
0
100
110
120
130
140
150
160
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved March
MARK LOPEZ J.L.PIERZGA 1977

FIGURE B 20

APPENDIX C

COMPARISON OF ITS PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT

Appendix C shows a comparison of measured and predicted data. The predicted data is based on the ITS computer outputs shown in Appendix E. Adjustments to the predictions have been made in order to account for slight differences in station EIRP's. Since many stations differed in EIRP by less than 1.0 dB, it seemed pointless to make 20 computer runs when 4 would siffice. Since the TACAN equipment was calibrated at the antenna output, no adjustment in the measured data was necessary.

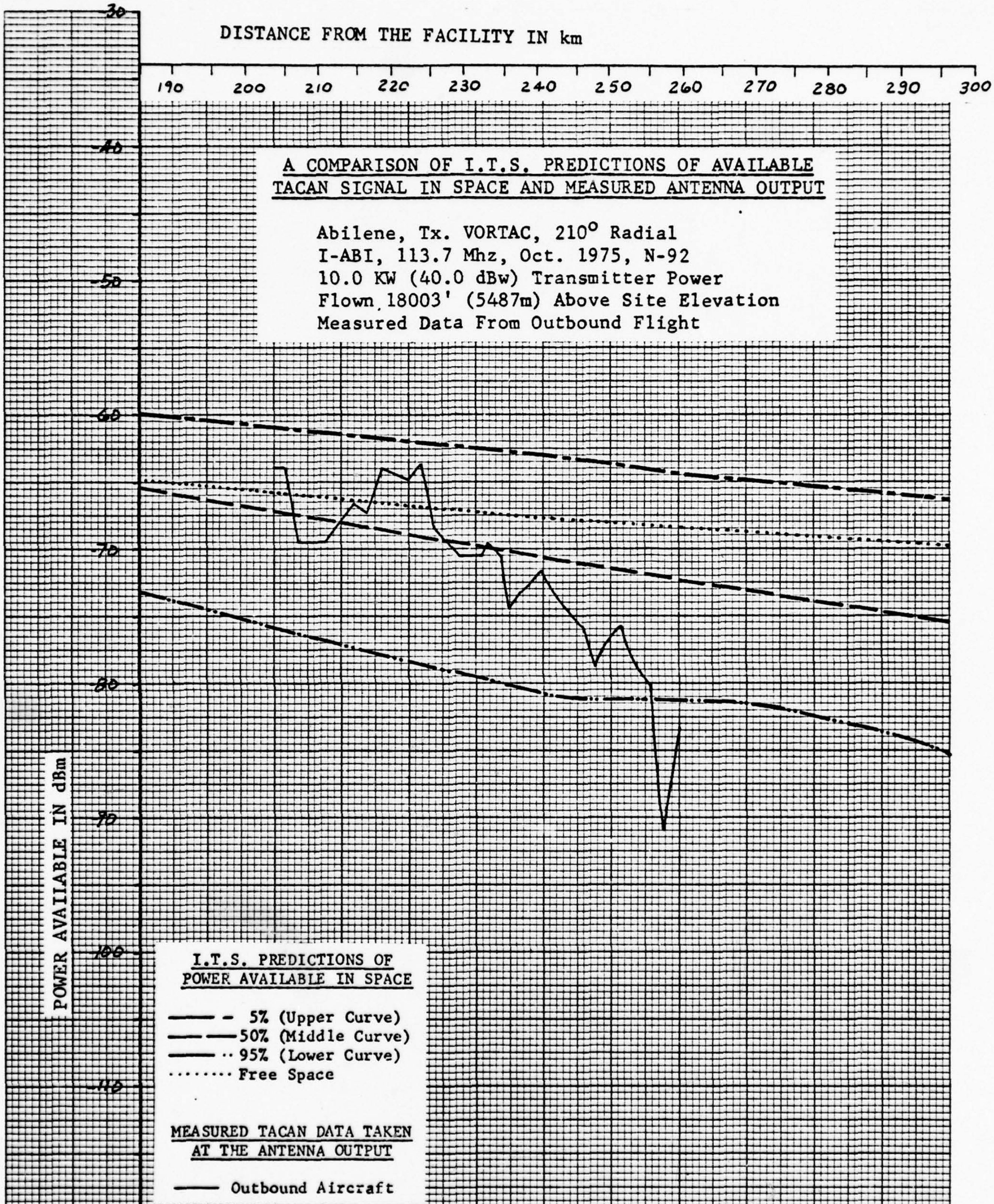

DISTANCE FROM THE FACILITY IN km
190
200
210
220
230
240
250
260
270
280
290
300
A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Abilene, Tx. VORTAC, 210° Radial
I-ABI, 113.7 Mhz, Oct. 1975, N-92
10.0 KW (40.0 dBw) Transmitter Power
Flown 18003' (5487m) Above Site Elevation
Measured Data From Outbound Flight
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
R.D.SMITH
Approved
J.L.PIERZGA
March
1977

FIGURE C 1

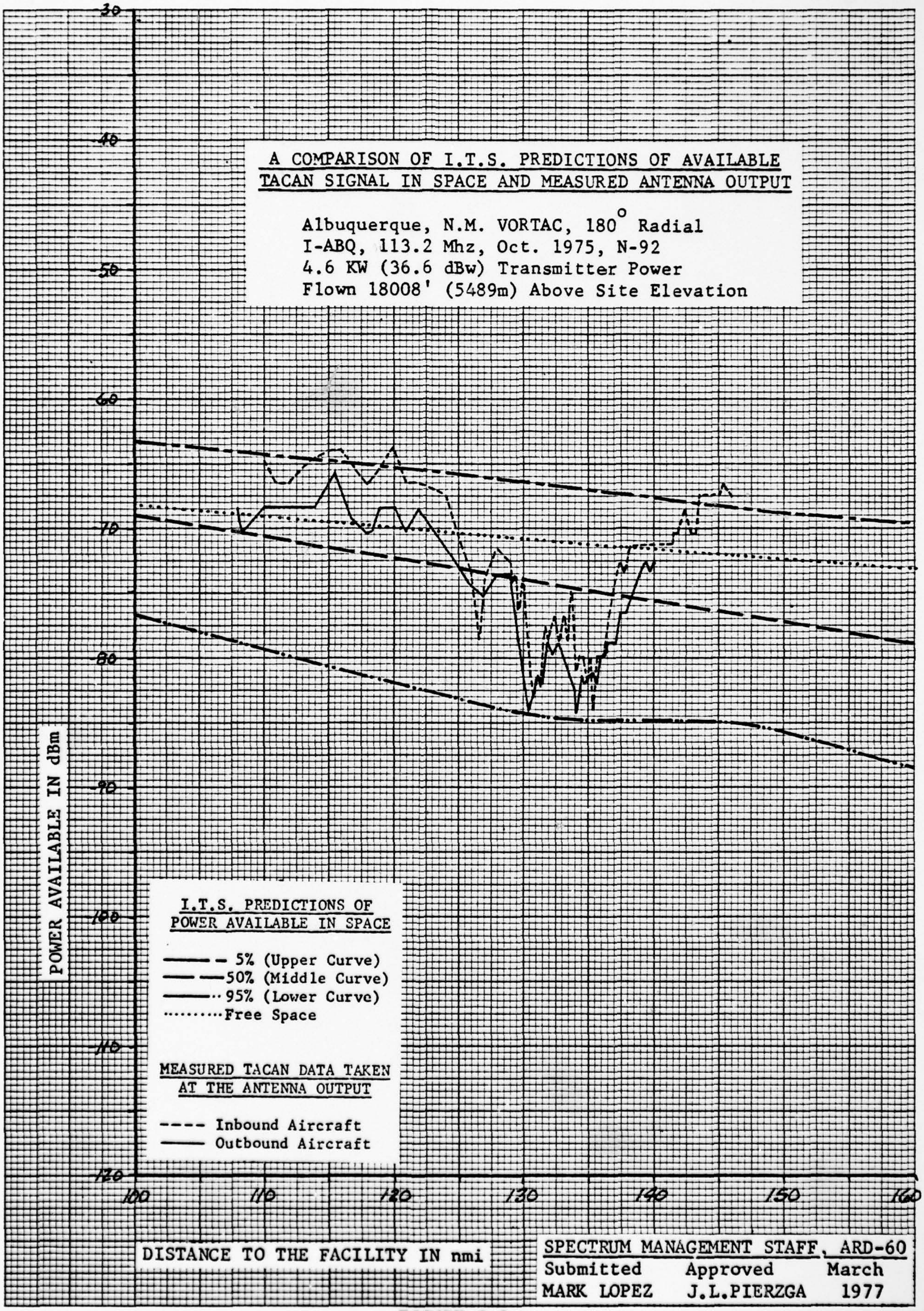
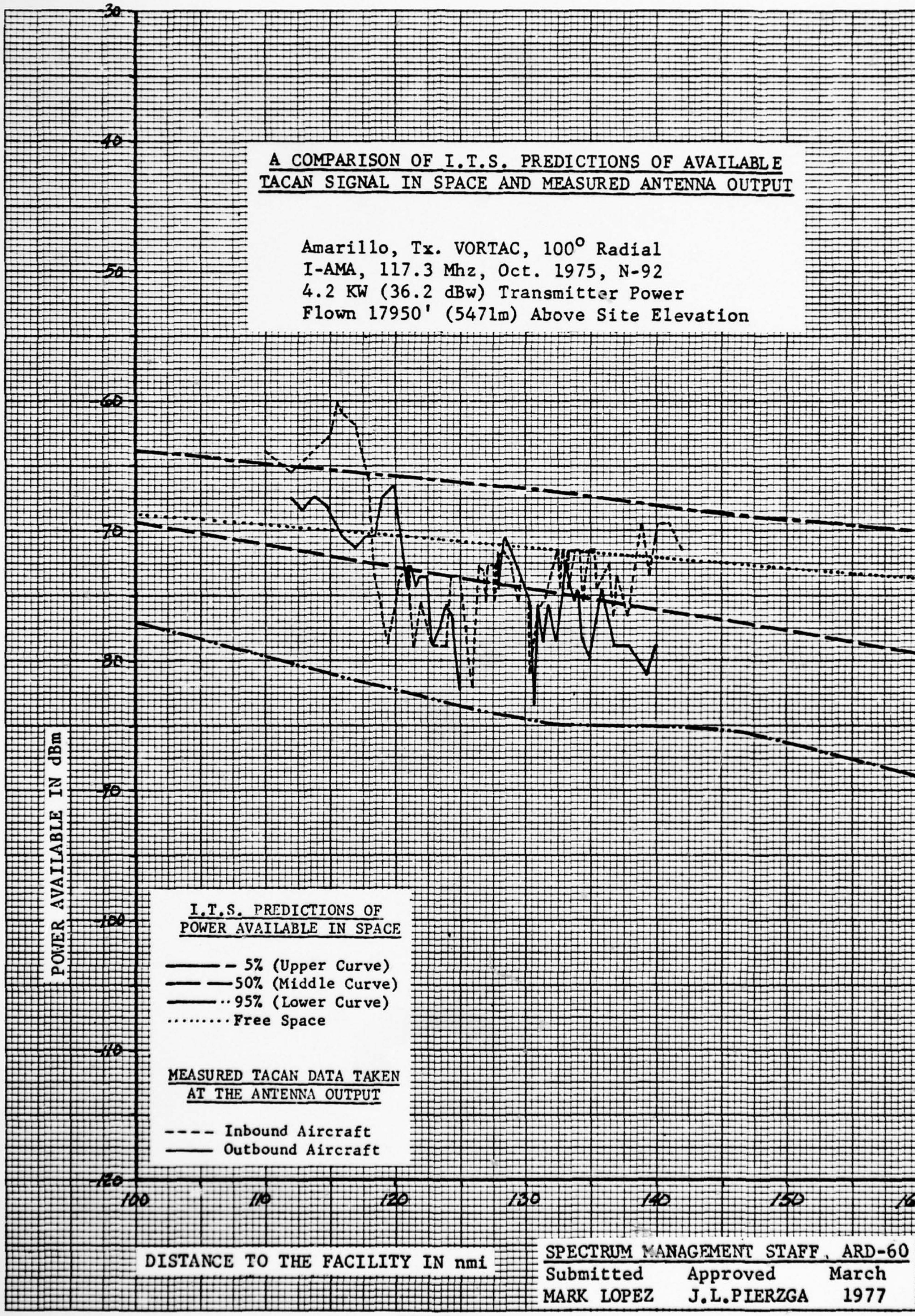

A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Albuquerque, N.M. VORTAC, 180° Radial
I-ABQ, 113.2 Mhz, Oct. 1975, N-92
4.6 KW (36.6 dBw) Transmitter Power
Flown 18008' (5489m) Above Site Elevation
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
MARK LOPEZ
Approved
J.L.PIERZGA
March
1977

FIGURE C 2



A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Amarillo, Tx. VORTAC, 100° Radial
I-AMA, 117.3 Mhz, Oct. 1975, N-92
4.2 KW (36.2 dBw) Transmitter Power
Flown 17950' (5471m) Above Site Elevation
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
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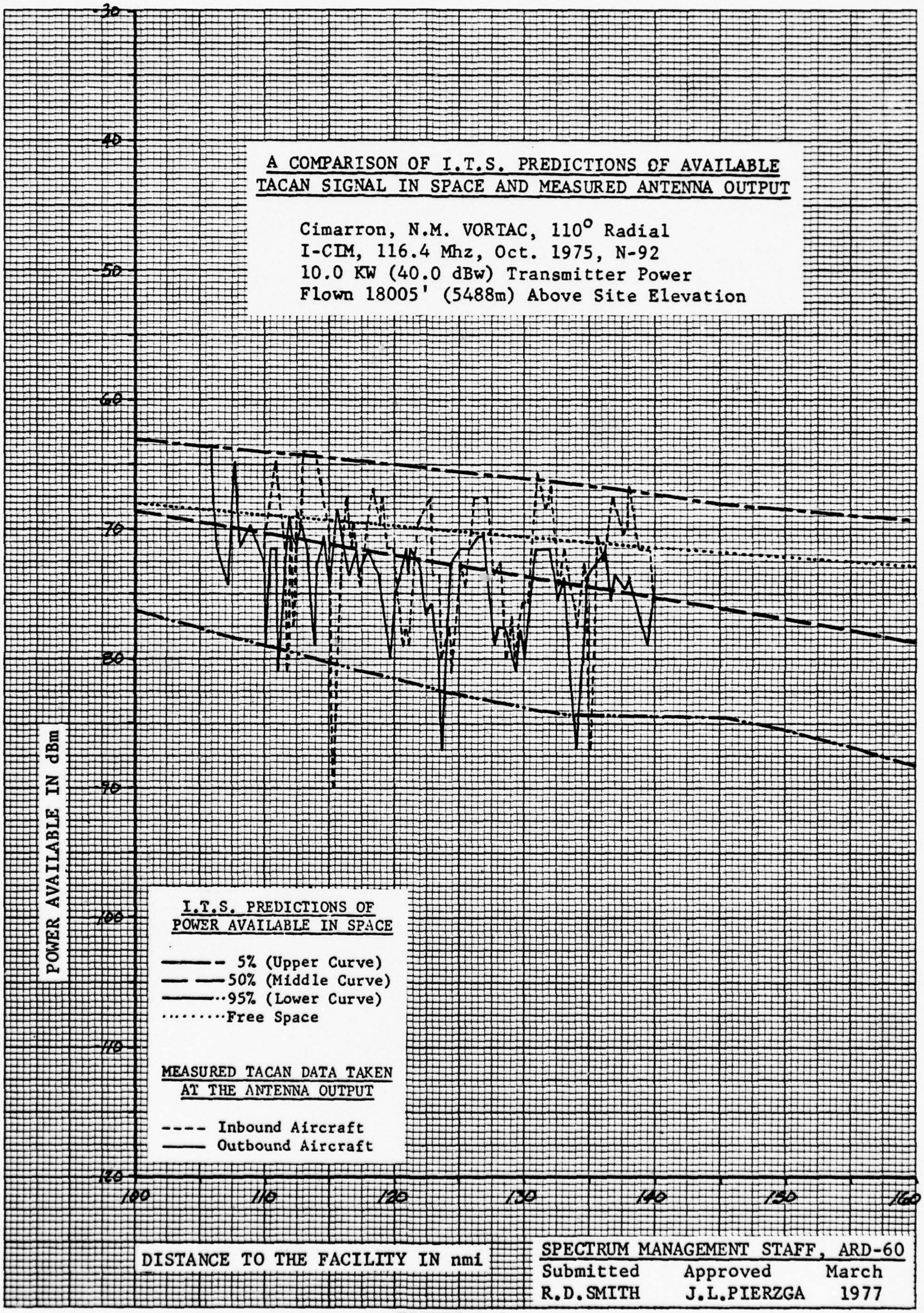
MARK LOPEZ
J.L.PIERZGA
1977

FIGURE C 3



A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Cimarron, N.M. VORTAC, 110° Radial
I-CIM, 116.4 Mhz, Oct. 1975, N-92
10.0 KW (40.0 dBw) Transmitter Power
Flown 18005' (5488m) Above Site Elevation
POWER AVAILABLE IN dBm
-30
40
-50
60
70
80
90
100
110
120
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
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Approved
J.L.PIERZGA
March
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FIGURE C 4

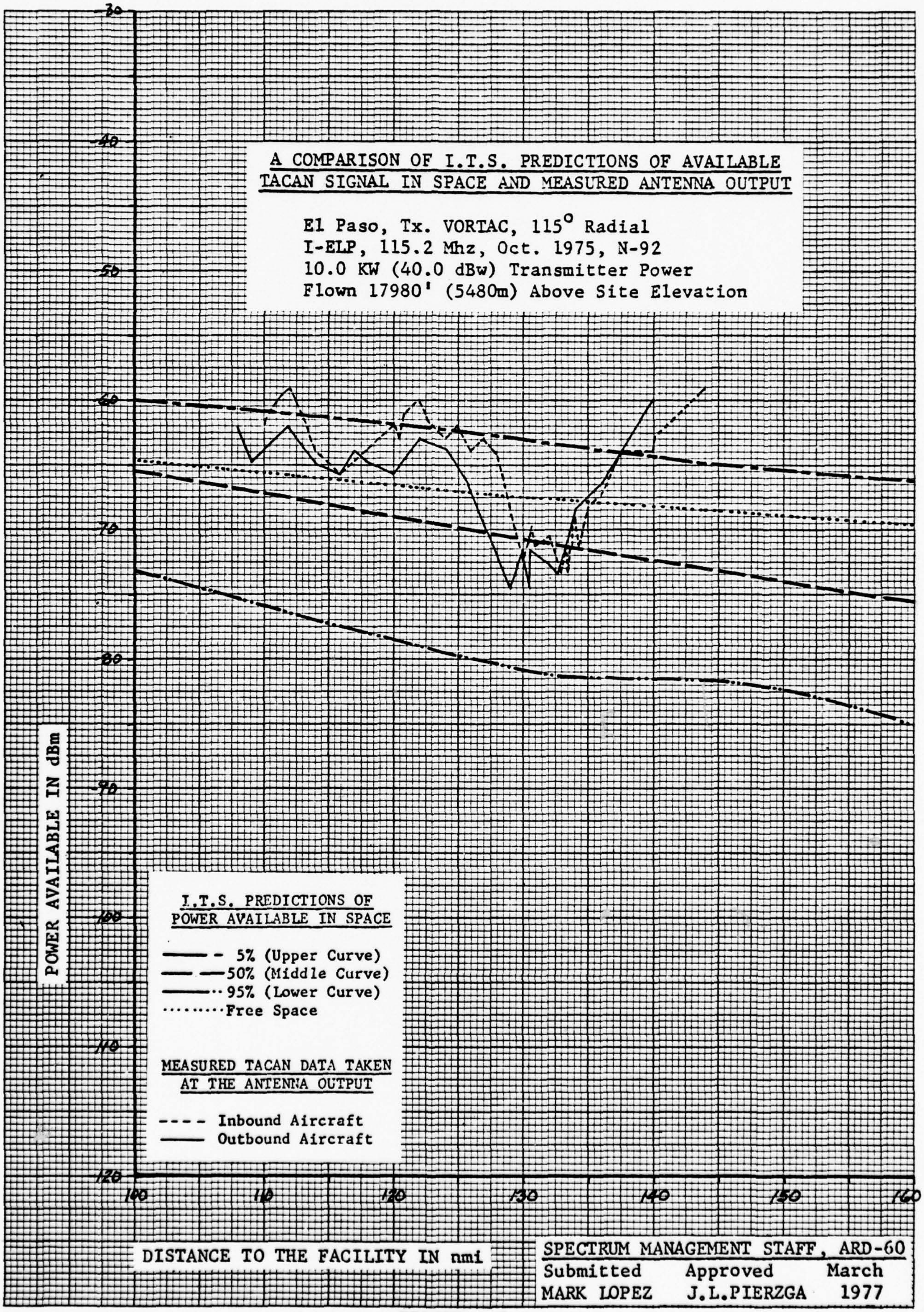

A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
El Paso, Tx. VORTAC, 115° Radial
I-ELP, 115.2 Mhz, Oct. 1975, N-92
10.0 KW (40.0 dBw) Transmitter Power
Flown 17980' (5480m) Above Site Elevation
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted MARK LOPEZ
Approved J.L.PIERZGA
March 1977

FIGURE C 5

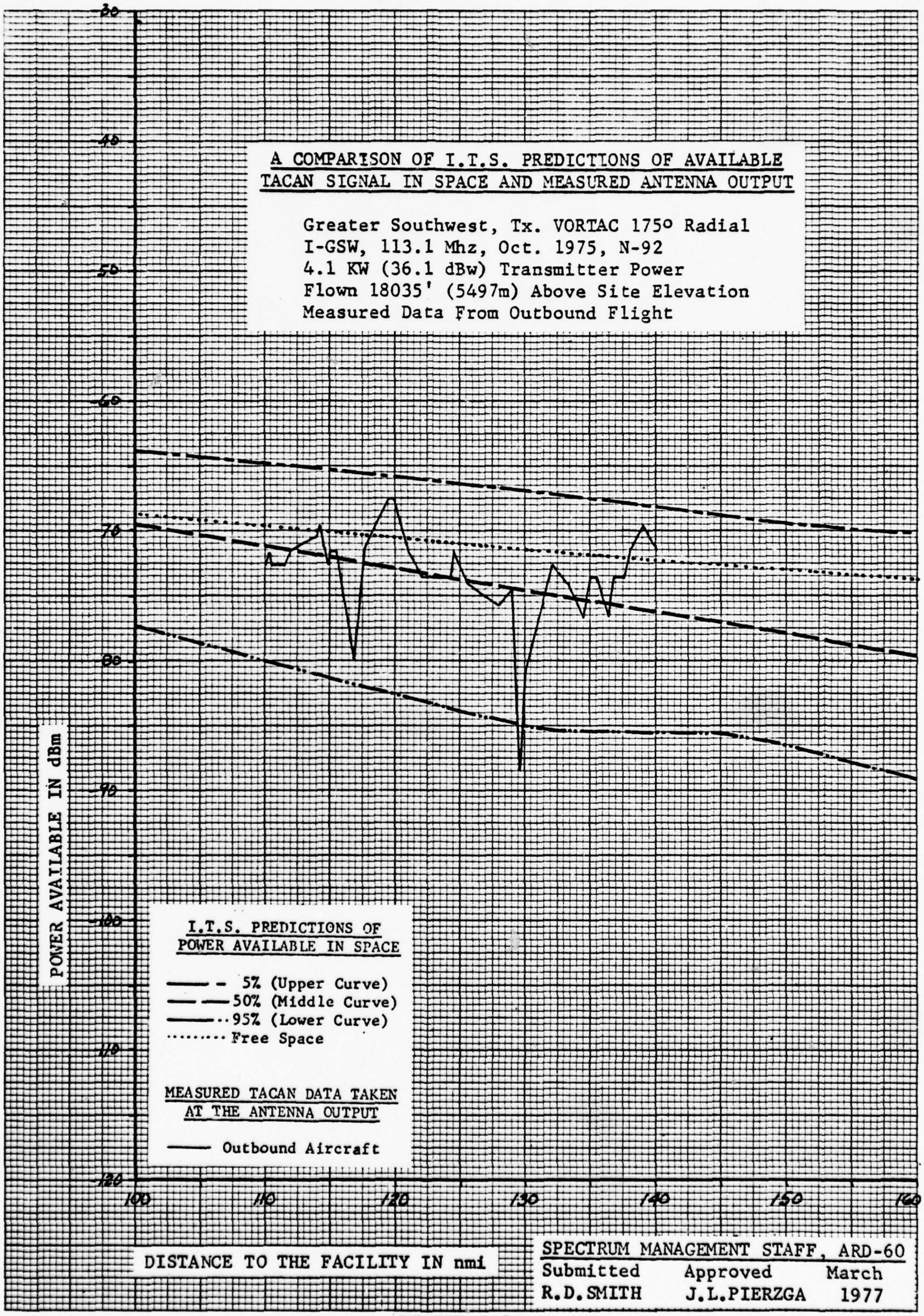

A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Greater Southwest, Tx. VORTAC 175° Radial
I-GSW, 113.1 Mhz, Oct. 1975, N-92
4.1 KW (36.1 dBw) Transmitter Power
Flown 18035' (5497m) Above Site Elevation
Measured Data From Outbound Flight
POWER AVAILABLE IN dBm
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted R.D.SMITH
Approved J.L.PIERZGA
March 1977

FIGURE C 6

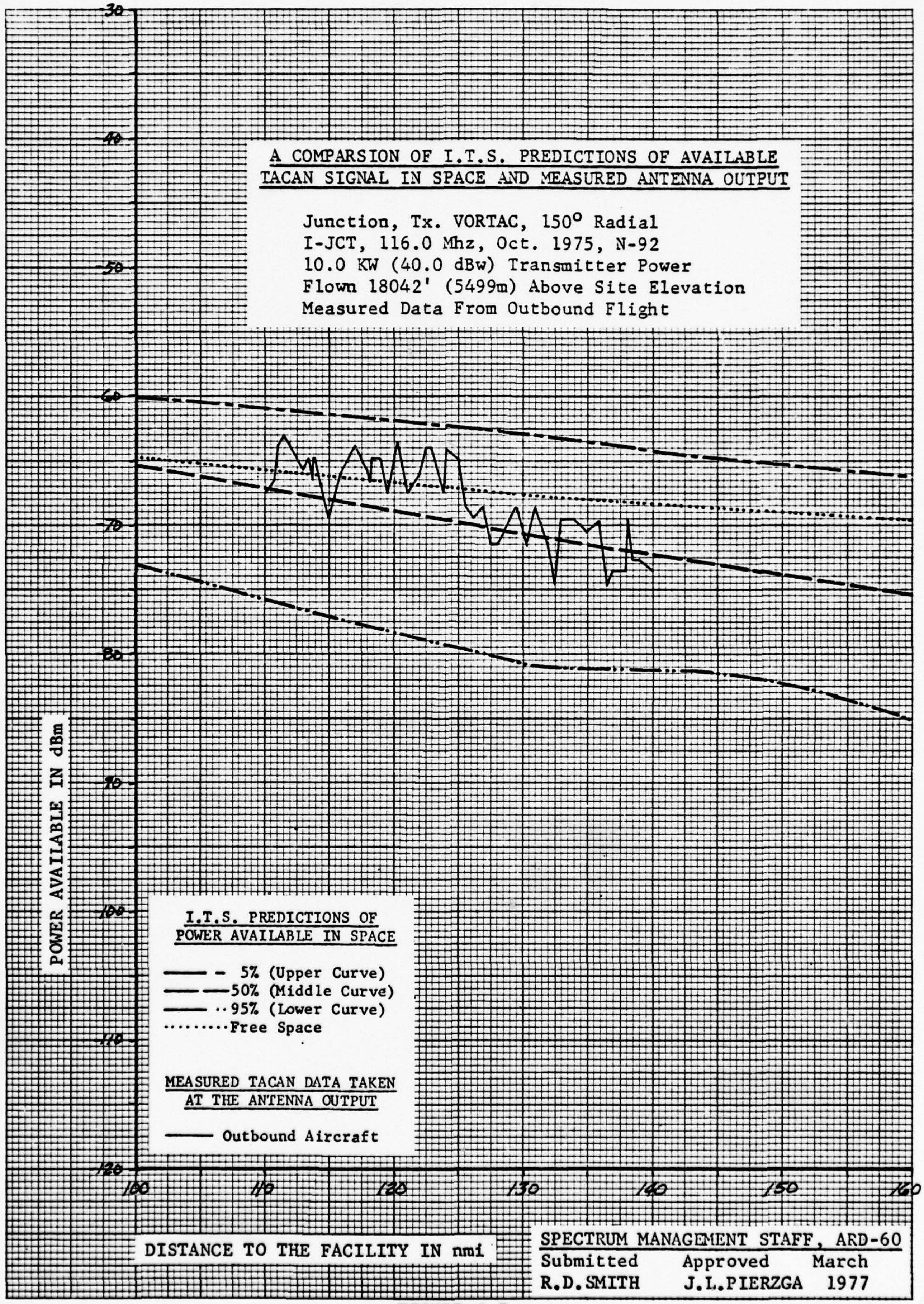
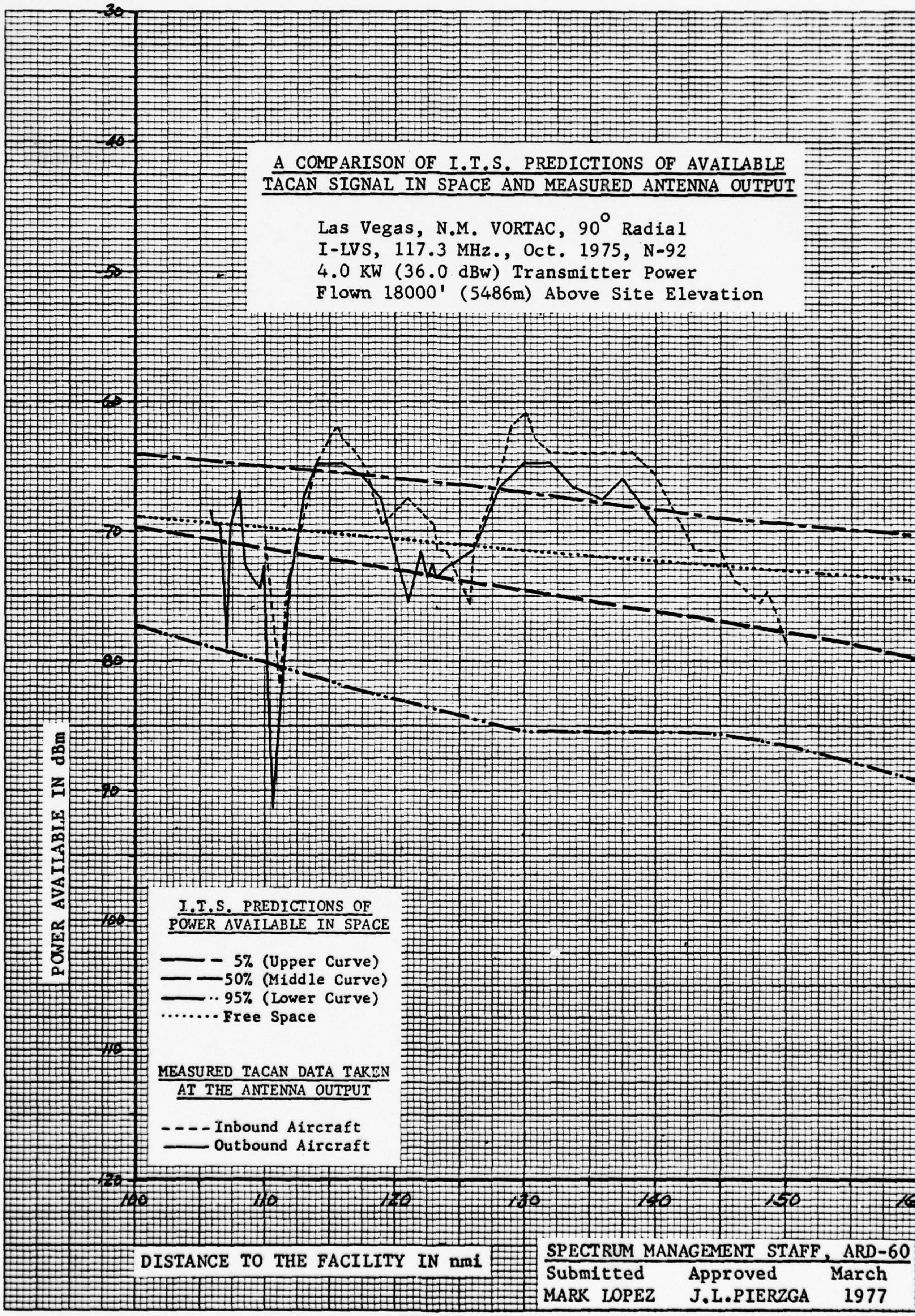

A COMPARSION OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Junction, Tx. VORTAC, 150° Radial
I-JCT, 116.0 Mhz, Oct. 1975, N-92
10.0 KW (40.0 dBw) Transmitter Power
Flown 18042' (5499m) Above Site Elevation
Measured Data From Outbound Flight
POWER AVAILABLE IN dBm
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved March
R.D.SMITH J.L.PIERZGA 1977

FIGURE C 7



A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Las Vegas, N.M. VORTAC, 90° Radial
I-LVS, 117.3 MHz., Oct. 1975, N-92
4.0 KW (36.0 dBw) Transmitter Power
Flown 18000' (5486m) Above Site Elevation
POWER AVAILABLE IN dBm
30
40
50
60
70
80
90
100
110
120
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
Approved
March
MARK LOPEZ
J.L.PIERZGA
1977

FIGURE C 8

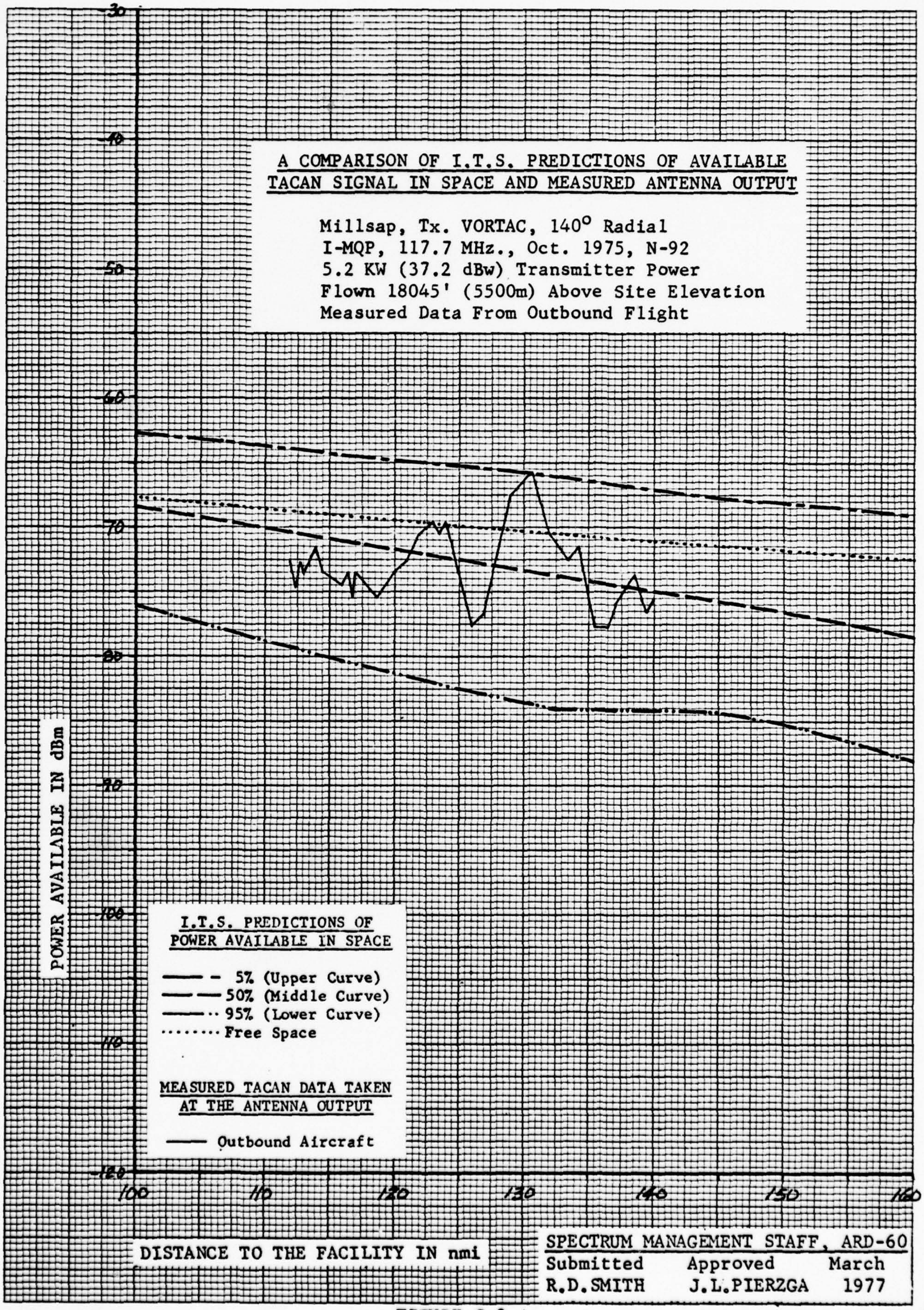

A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE
TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Millsap, Tx. VORTAC, 140° Radial
I-MQP, 117.7 MHz., Oct. 1975, N-92
5.2 KW (37.2 dBw) Transmitter Power
Flown 18045' (5500m) Above Site Elevation
Measured Data From Outbound Flight
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF
POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN
AT THE ANTENNA OUTPUT
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved March
R.D.SMITH J.L.PIERZGA 1977

FIGURE C 9

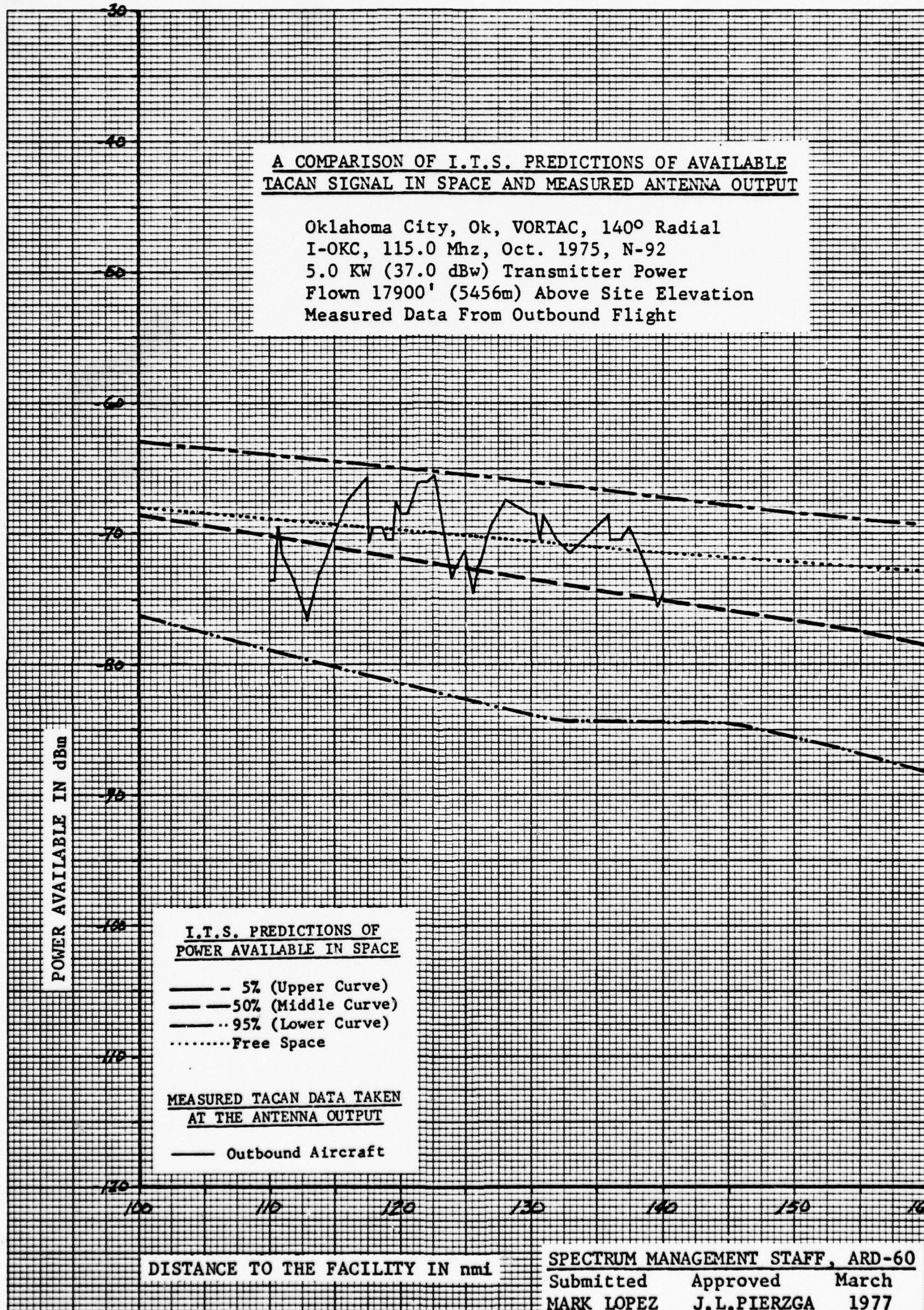

A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Oklahoma City, Ok, VORTAC, 140° Radial
I-OKC, 115.0 Mhz, Oct. 1975, N-92
5.0 KW (37.0 dBw) Transmitter Power
Flown 17900' (5456m) Above Site Elevation
Measured Data From Outbound Flight
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
100
110
120
130
140
150
160
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
MARK LOPEZ
Approved
J.L.PIERZGA
March
1977

FIGURE C 10

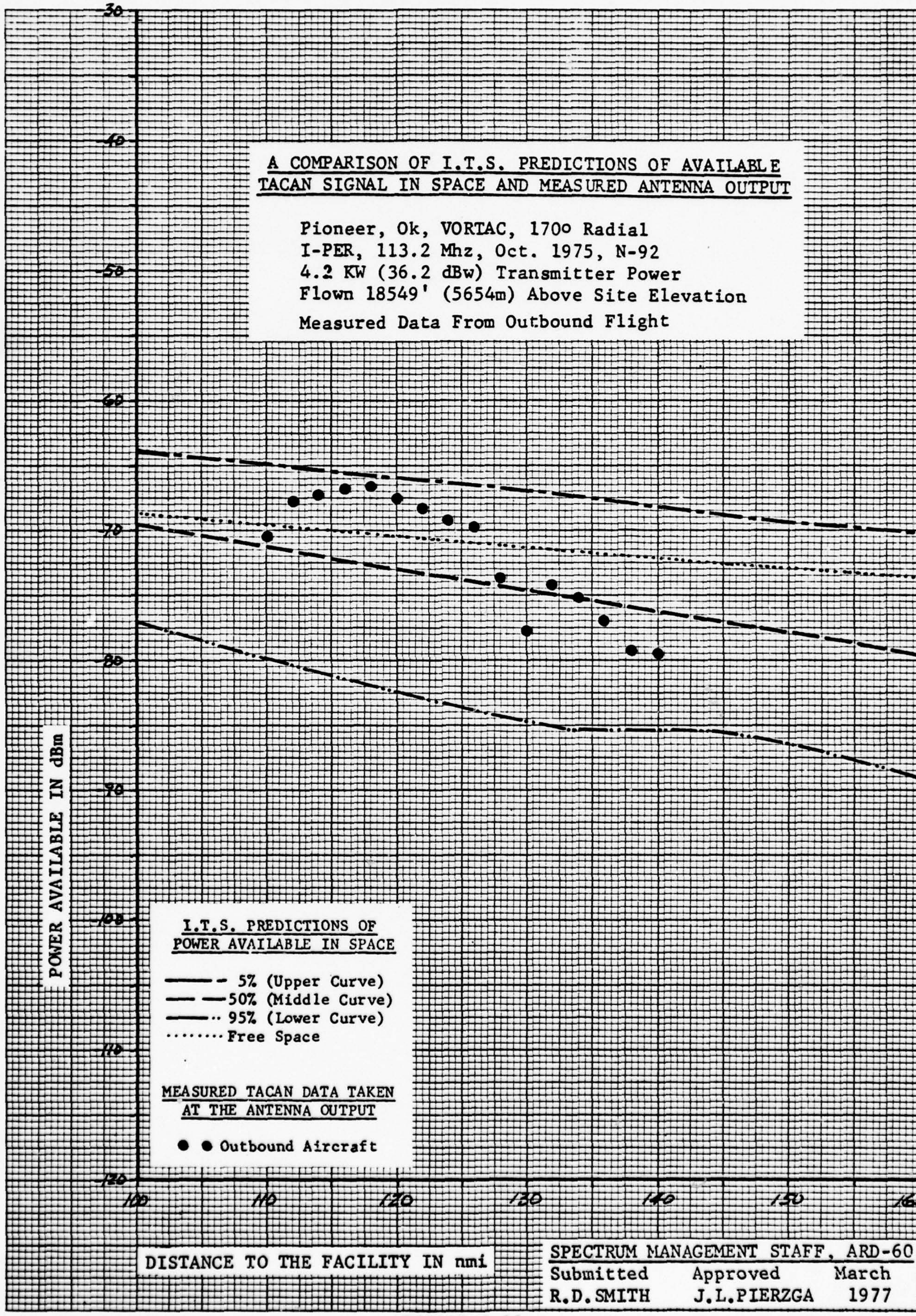
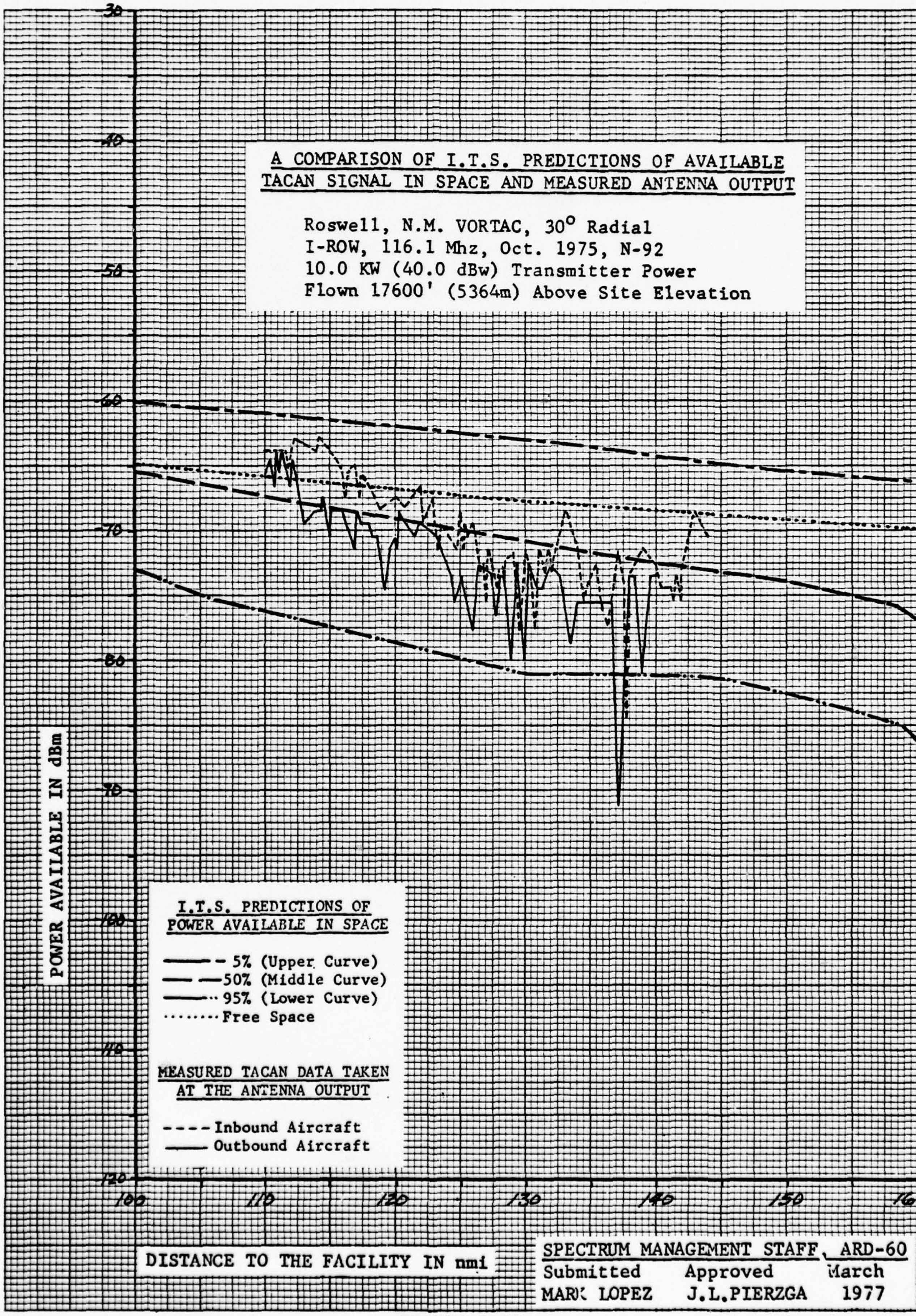
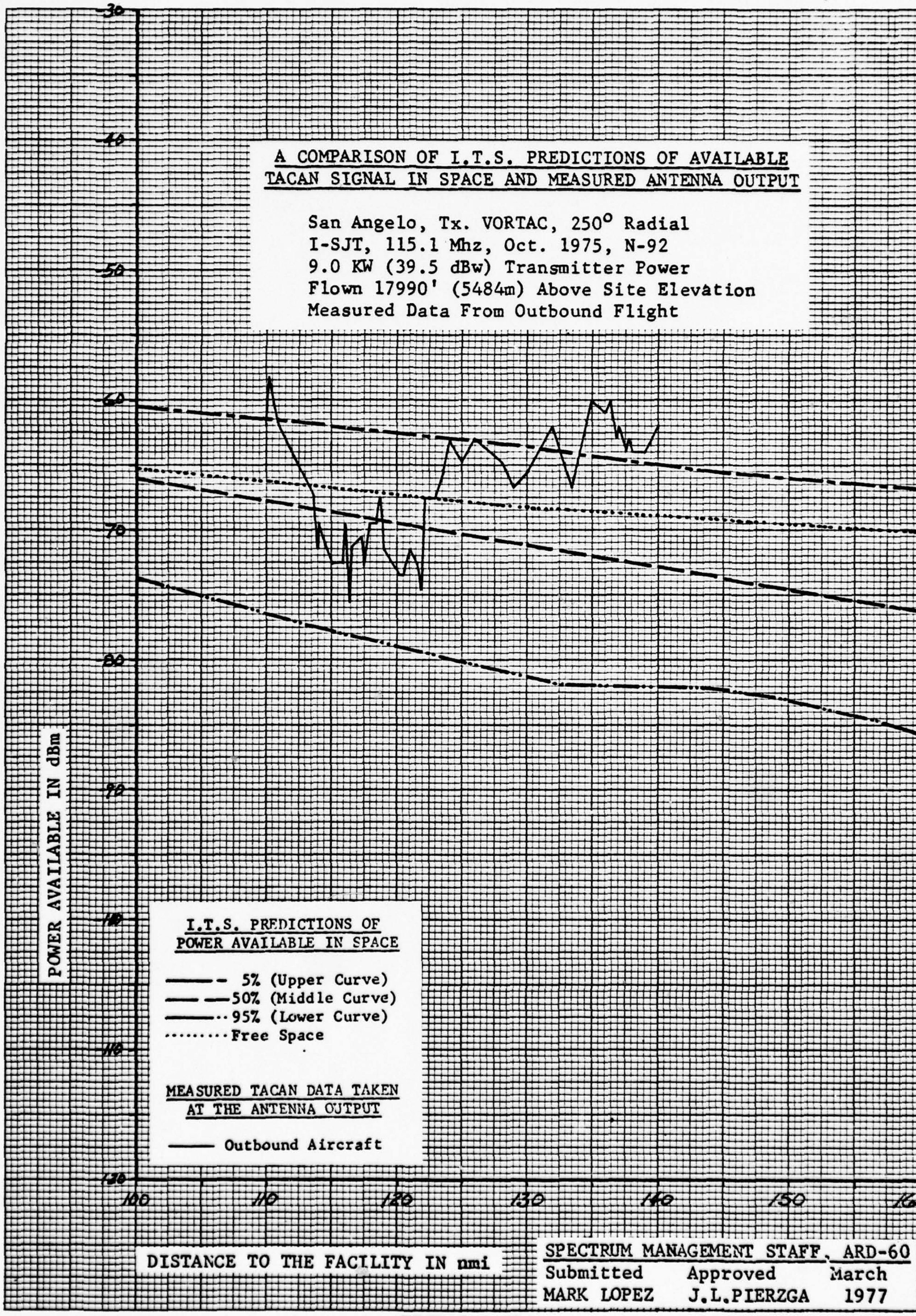

A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Pioneer, Ok, VORTAC, 170o Radial
I-PER, 113.2 Mhz, Oct. 1975, N-92
4.2 KW (36.2 dBw) Transmitter Power
Flown 18549' (5654m) Above Site Elevation
Measured Data From Outbound Flight
30
40
50
60
70
80
90
100
110
120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted R.D.SMITH
Approved J.L.PIERZGA
March 1977

FIGURE C 11



A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE
TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Roswell, N.M. VORTAC, 30° Radial
I-ROW, 116.1 Mhz, Oct. 1975, N-92
10.0 KW (40.0 dBw) Transmitter Power
Flown 17600' (5364m) Above Site Elevation
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF
POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN
AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved March
MARK LOPEZ J.L.PIERZGA 1977

FIGURE C 12



A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
San Angelo, Tx. VORTAC, 250° Radial
I-SJT, 115.1 Mhz, Oct. 1975, N-92
9.0 KW (39.5 dBw) Transmitter Power
Flown 17990' (5484m) Above Site Elevation
Measured Data From Outbound Flight
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
100
110
120
130
140
150
160
POWER AVAILABLE IN dBm
DISTANCE TO THE FACILITY IN nmi
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted MARK LOPEZ
Approved J.L.PIERZGA
March 1977

FIGURE C 13

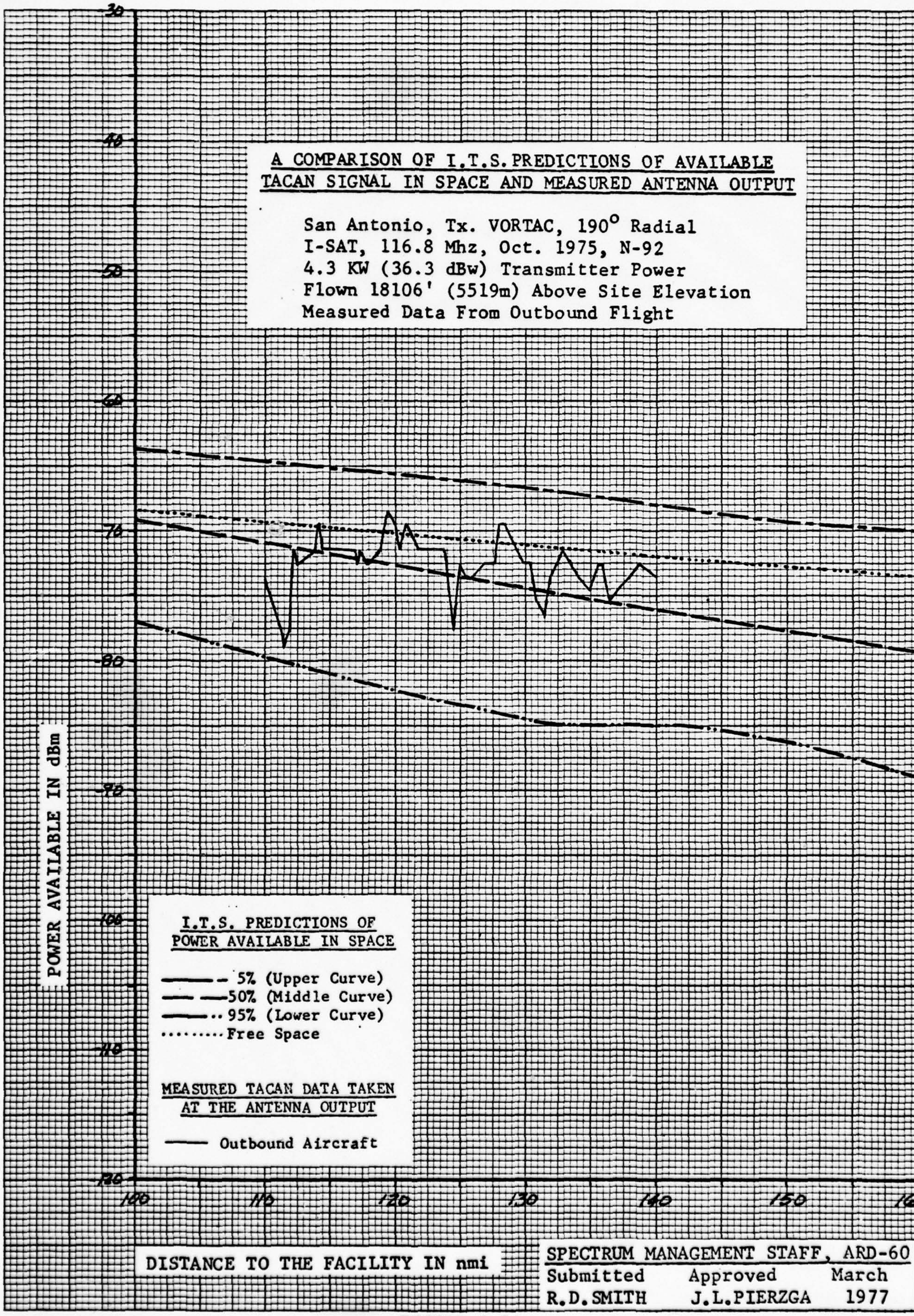

A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
San Antonio, Tx. VORTAC, 190° Radial
I-SAT, 116.8 Mhz, Oct. 1975, N-92
4.3 KW (36.3 dBw) Transmitter Power
Flown 18106' (5519m) Above Site Elevation
Measured Data From Outbound Flight
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
POWER AVAILABLE IN dBm
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted R.D. SMITH
Approved J.L. PIERZGA
March 1977

FIGURE C 14

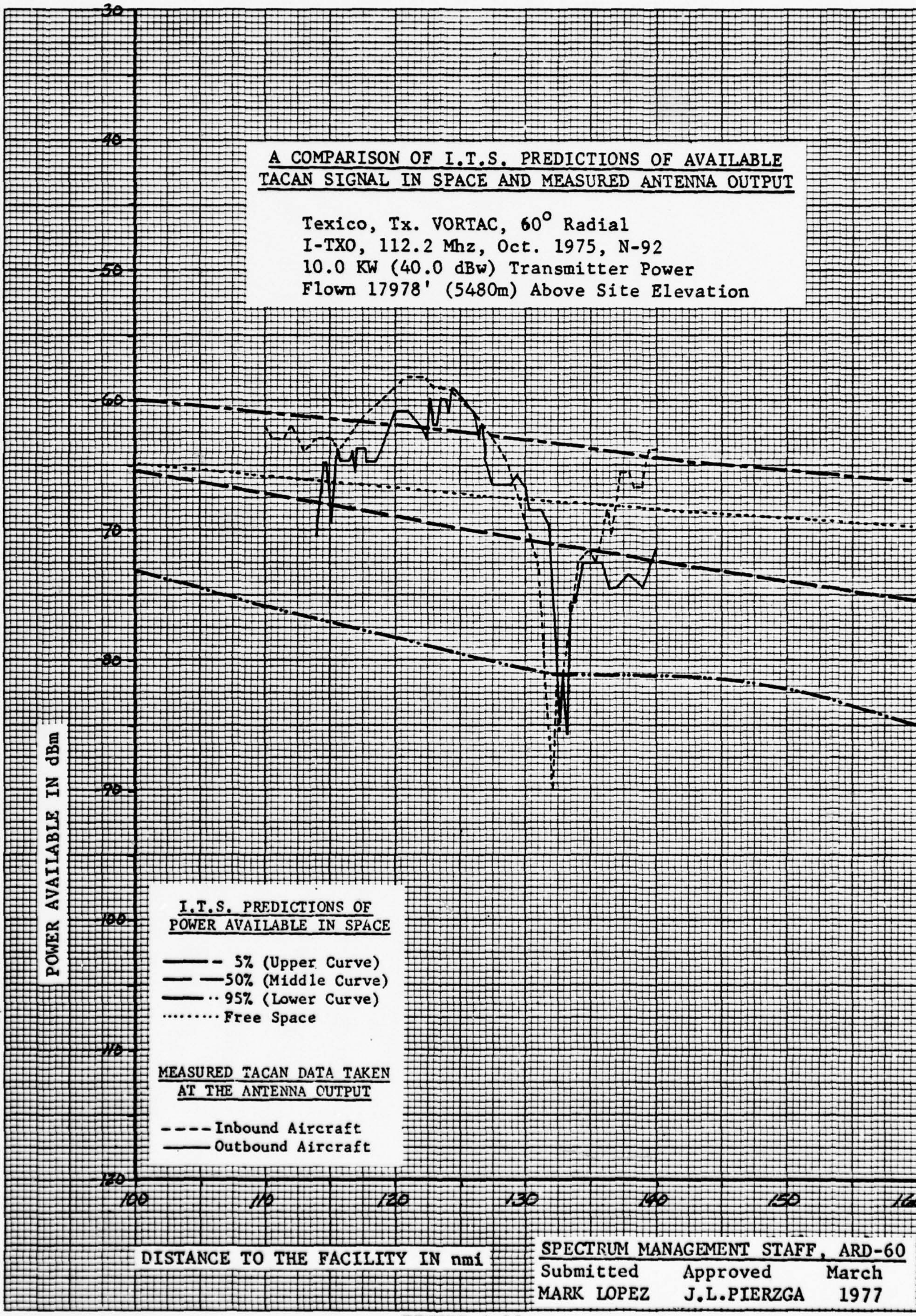
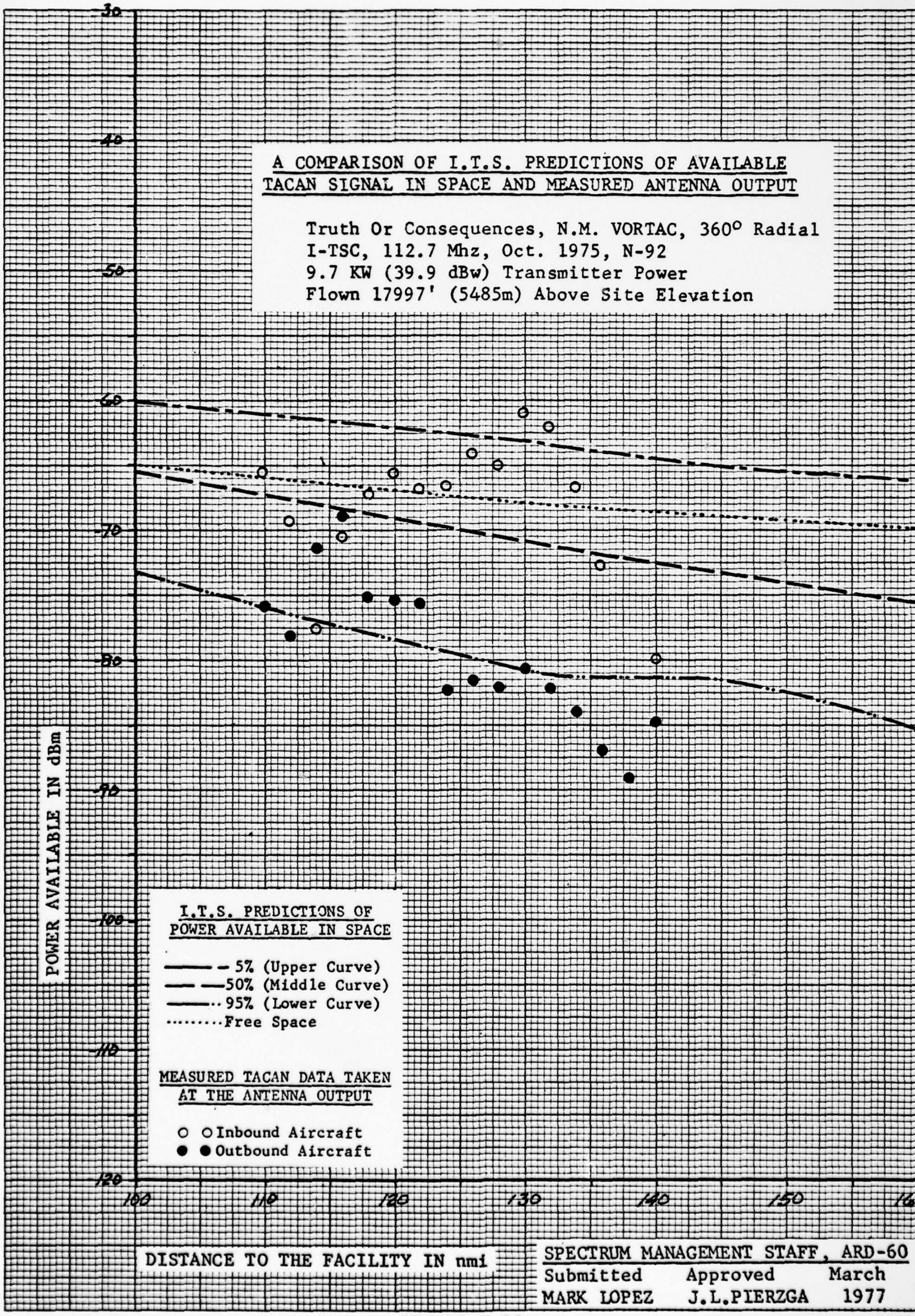

A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Texico, Tx. VORTAC, 60° Radial
I-TXO, 112.2 Mhz, Oct. 1975, N-92
10.0 KW (40.0 dBw) Transmitter Power
Flown 17978' (5480m) Above Site Elevation
30
40
50
60
70
80
90
100
110
120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved March
MARK LOPEZ J.L.PIERZGA 1977

FIGURE C 15



A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Truth Or Consequences, N.M. VORTAC, 360° Radial
I-TSC, 112.7 Mhz, Oct. 1975, N-92
9.7 KW (39.9 dBw) Transmitter Power
Flown 17997' (5485m) Above Site Elevation
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
POWER AVAILABLE IN dBm
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved March
MARK LOPEZ J.L.PIERZGA 1977

FIGURE C 16

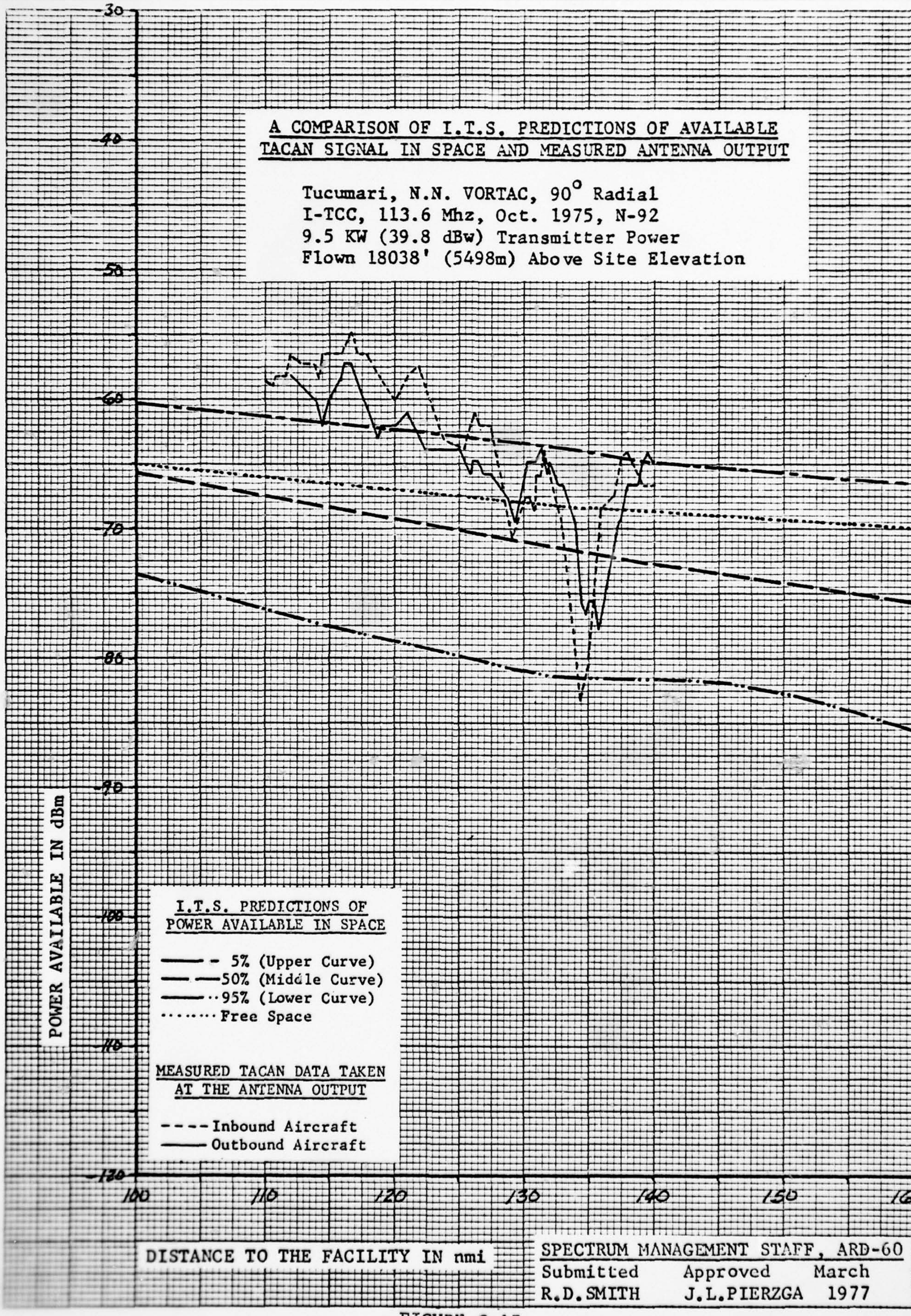


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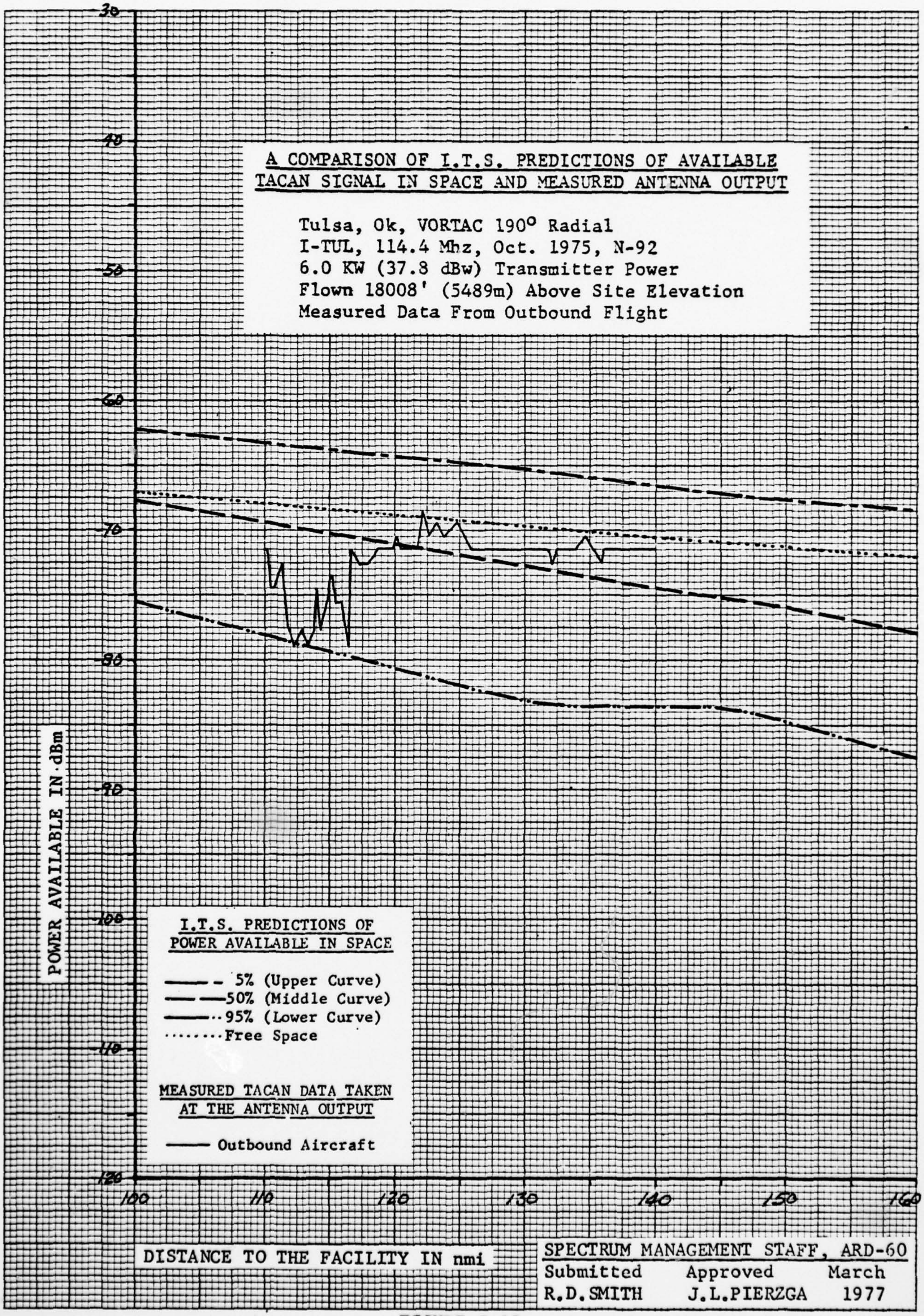
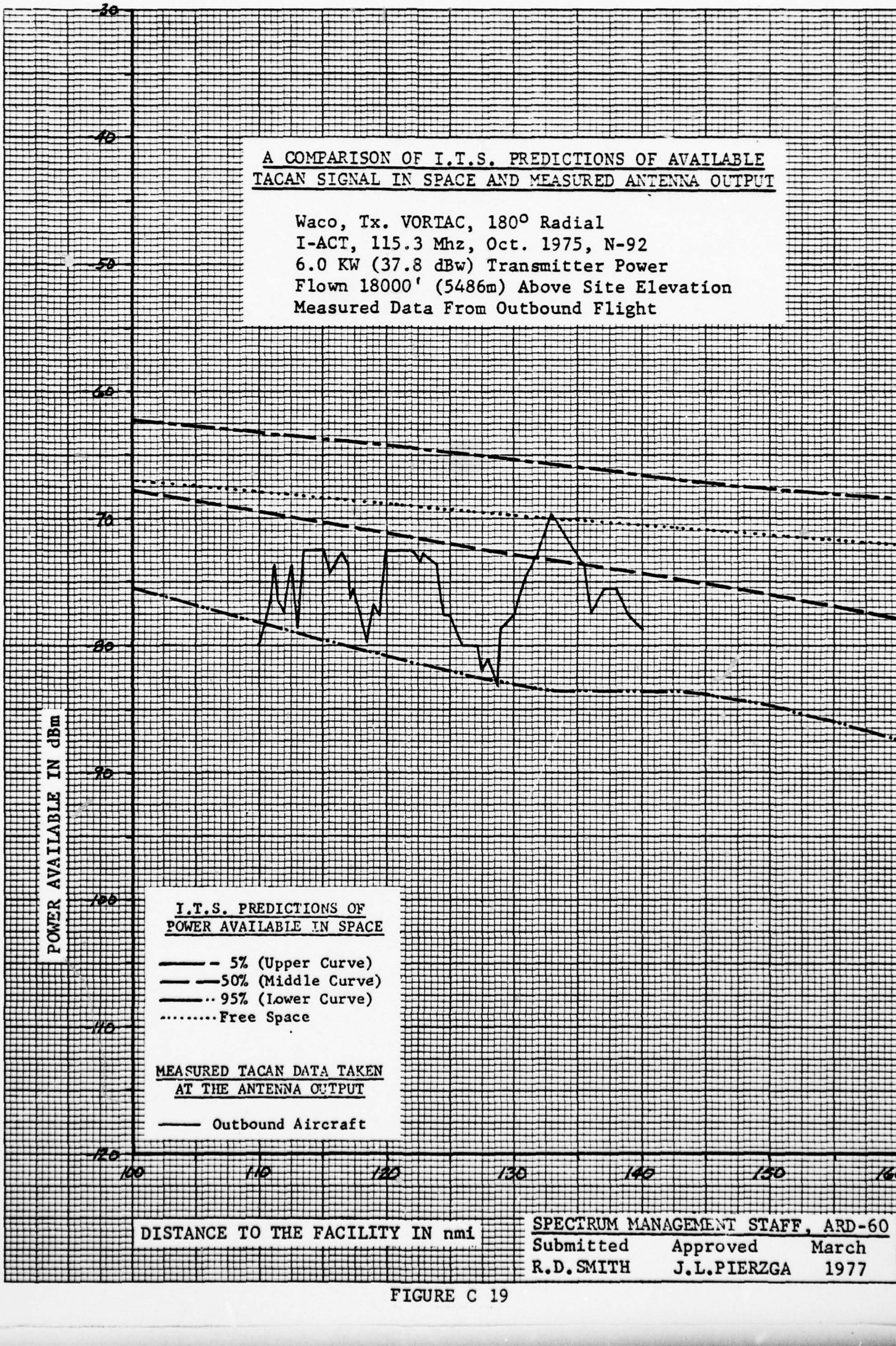
FIGURE C 17



A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE
TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Tulsa, Ok, VORTAC 190° Radial
I-TUL, 114.4 Mhz, Oct. 1975, N-92
6.0 KW (37.8 dBw) Transmitter Power
Flown 18008' (5489m) Above Site Elevation
Measured Data From Outbound Flight
I.T.S. PREDICTIONS OF
POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN
AT THE ANTENNA OUTPUT
Outbound Aircraft
POWER AVAILABLE IN dBm
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
R.D.SMITH
Approved
J.L.PIERZGA
March
1977

FIGURE C 18



A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Waco, Tx. VORTAC, 180° Radial
I-ACT, 115.3 Mhz, Oct. 1975, N-92
6.0 KW (37.8 dBw) Transmitter Power
Flown 18000' (5486m) Above Site Elevation
Measured Data From Outbound Flight
POWER AVAILABLE IN dBm
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
R.D.SMITH
Approved
J.L.PIERZGA
March
1977

FIGURE C 19

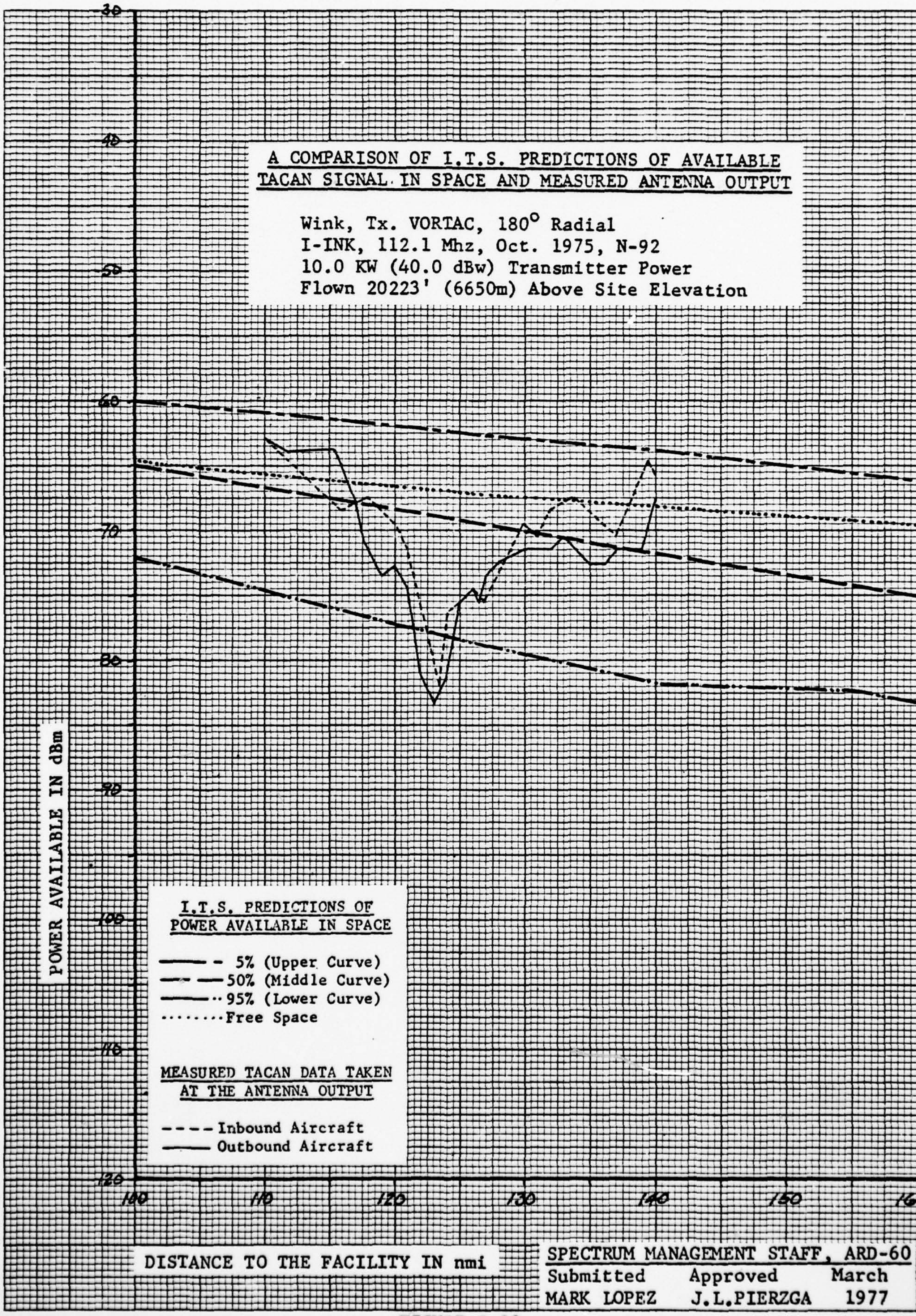

A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Wink, Tx. VORTAC, 180° Radial
I-INK, 112.1 Mhz, Oct. 1975, N-92
10.0 KW (40.0 dBw) Transmitter Power
Flown 20223' (6650m) Above Site Elevation
POWER AVAILABLE IN dBm
30
40
50
60
70
80
90
100
110
120
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted MARK LOPEZ
Approved J.L.PIERZGA
March 1977

FIGURE C 20

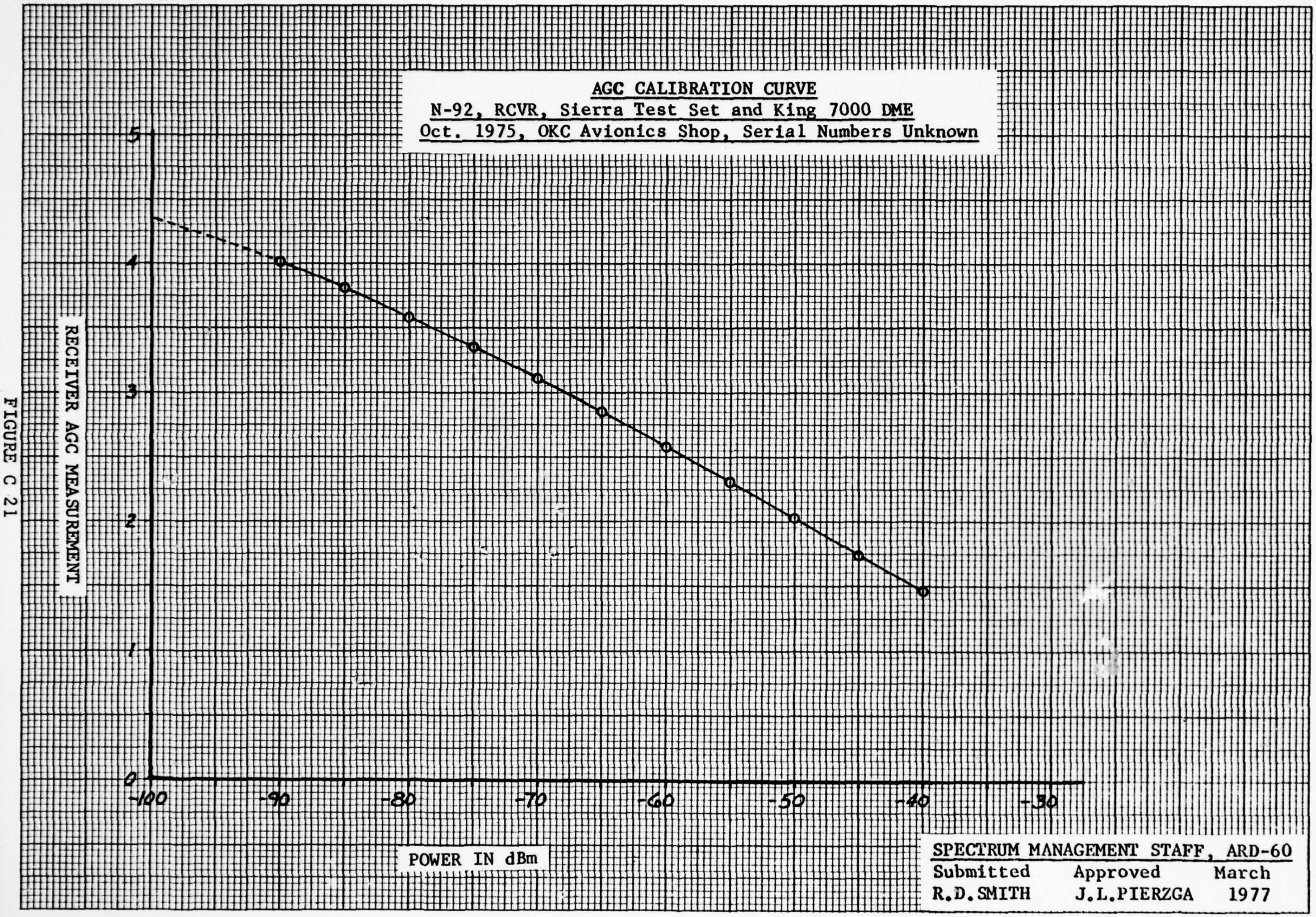

AGC CALIBRATION CURVE
N-92, RCVR, Sierra Test Set and King 7000 DME
Oct. 1975, OKC Avionics Shop, Serial Numbers Unknown
RECEIVER AGC MEASUREMENT
5
4
3
2
1
0
-100
-90
-80
-70
-60
-50
-40
-30
POWER IN dBm
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved March
R.D.SMITH J.L.PIERZGA 1977

FIGURE C 21

APPENDIX D

DIFFERENCE BETWEEN INBOUND AND OUTBOUND SIGNALS

Data taken on inbound and outbound flights shows a decided difference in signal strength. It is assumed that this difference is due entirely to the difference in airborne antenna gains for the two orientations. (The inbound and outbound flights were done consecutively.) The calculations, shown in this appendix, were done in order to quantify this difference more precisely.

Data points were taken every 2 nmi from strip chart measurements of five facilities. Inbound and outbound signals were compared and the signal differences determined. Data was ignored if notes on the strip chart recordings indicated that the plane was still turning near the start of a run or if a TACAN unlock was noted. Calculations show the average difference in received signals.

AVERAGE DIFFERENCES BETWEEN
INBOUND AND OUTBOUND SIGNALS

	VOR	TACAN
ABQ	5.2	2.7
AMA	6.3	1.6
LVS	6.1	1.9
ROW	5.5	2.5
TCC	4.2	1.6
	27.3	10.3
Average	5.46 dB	2.06 dB

The inbound signals are this much larger than the outbound signals on the average.

ABQ VOR

DIFFERENCE BETWEEN INBOUND AND OUTBOUND SIGNALS

	INBOUND			OUTBOUND			
DISTANCE	AGC	uV	dBm	AGC	uV	dBm	SIGNAL DIFFERENCE
110	6.0	25	-79.0	5.1	12.6	-84.9	5.9
112	5.95	24	-79.4	5.1	12.6	-84.9	5.5
114	5.9	23	-79.8	5.0	11.8	-85.6	5.8
116	5.8	21	-80.7	4.9	10.9	-86.2	5.5
118	5.75	20	-80.9	4.85	10.5	-86.5	5.6
120	5.7	19.8	-81.0	4.85	10.5	-86.5	5.5
122	5.65	19	-81.4	4.8	10.1	-86.9	5.5
124	5.6	18.1	-81.8	4.75	9.7	-87.3	5.5
126	5.55	17.4	-82.2	4.7	9.3	-87.7	5.5
128	5.5	16.7	-82.6	4.6	8.5	-88.3	5.7
130	5.35	14.9	-83.6	4.6	8.5	-88.3	4.7
132	5.3	14.4	-83.8	4.55	8.1	-88.8	5.0
134	5.25	13.9	-84.0	4.5	7.8	-89.1	5.1
136	5.05	12.2	-85.0	4.45	7.4	-89.6	4.6
138	4.95	11.4	-85.8	4.4	7.1	-90.0	4.2
140	4.85	10.5	-86.5	4.4	7.1	-90.0	3.5
			-1317.5			-1400.6	83.1

THE AVERAGE DIFFERENCE IN RECEIVED SIGNAL IS 5.2 dB.

ABQ TACAN

DIFFERENCE BETWEEN INBOUND AND OUTBOUND SIGNALS

DISTANCE	INBOUND AGC	INBOUND dBm	OUTBOUND AGC	OUTBOUND dBM	SIGNAL DIFFERENCE
110	2.85	-64.8	3.05	-68.5	3.7
112	2.95	-66.6	3.05	-68.5	1.9
114	2.85	-64.8	3.05	-68.5	3.7
116	2.80	-63.9	2.95	-66.6	2.7
118	2.95	-66.6	3.15	-70.5	3.9
120	2.80	-63.9	3.05	-68.5	4.6
122	2.95	-66.6	3.05	-68.5	1.9
124	3.00	-67.5	3.20	-71.5	4.0
126	3.30	-73.6	3.35	-74.6	1.0
128	3.20	-71.5	3.30	-73.6	2.1
130	3.40	-75.6	3.65	-81.1	5.5
132	3.55	-78.9	3.55	-78.9	0
134	3.55	-78.9	3.70	-82.2	3.3
136	3.60	-80.0	3.60	-80.0	0
138	3.25	-72.6	3.45	-76.6	4.0
140	3.20	-71.5	3.25	-72.6	1.1
		-1127.3		-1170.7	43.4

THE AVERAGE DIFFERENCE IN RECEIVED SIGNAL IS 2.7 dB.

AMA VOR

DIFFERENCE BETWEEN INBOUND AND OUTBOUND SIGNALS

DISTANCE	INBOUND AGC	INBOUND uV	INBOUND dBm	OUTBOUND AGC	OUTBOUND uV	OUTBOUND dBm	SIGNAL DIFFERENCE
110	-	-	-	AIRCRAFT			-
112	-	-	-	TURNING			-
114	6.0	25	-79.0	4.8	10.1	-86.9	7.9
116	6.0	25	-79.0	4.75	9.7	-87.3	8.3
118	5.9	23	-79.8	4.8	10.1	-86.9	7.1
120	5.8	21	-80.7	4.6	8.5	-88.3	7.6
122	5.6	18.1	-81.8	4.55	8.1	-88.8	7.0
124	5.7	19.8	-81.0	4.6	8.5	-88.3	7.3
126	5.6	18.1	-81.8	4.5	7.8	-89.1	7.3
128	5.5	16.7	-82.6	4.5	7.8	-89.1	6.5
130	5.4	15.3	-83.2	4.45	7.4	-89.6	6.4
132	5.3	14.4	-83.8	4.35	6.8	-90.3	6.5
134	5.1	12.6	-84.9	4.3	6.5	-90.8	5.9
136	4.9	10.9	-86.1	4.4	7.1	-90.0	3.9
138	4.8	10.1	-86.9	4.35	6.8	-90.3	3.4
140	4.7	9.3	-87.7	4.25	6.2	-91.2	3.5
			-1158.3			-1246.9	88.6

THE AVERAGE DIFFERENCE IN RECEIVED SIGNAL IS 6.3 dB.

AMA TACAN

DIFFERENCE BETWEEN INBOUND AND OUTBOUND SIGNAL

DISTANCE	INBOUND AGC	INBOUND dBm	OUTBOUND AGC	OUTBOUND dBm	SIGNAL DIFFERENCE
110	2.8	-63.9	2.75	-63	-0.9
112	2.9	-65.7	3.0	-67.5	1.8
114	2.8	-63.9	3.0	-67.5	3.6
116	2.65	-61.0	3.15	-70.5	9.5
118	2.9	-65.7	3.15	-70.5	4.8
120	3.4	-75.6	2.95	-66.6	-9.0
122	3.4	-75.6	3.3	-73.6	-2.0
124	3.5	-78.9	3.4	-75.6	-3.3
126	-	-	UNLOCK		-
128	3.3	-73.6	3.25	-72.6	-1.0
130	3.35	-74.6	3.35	-74.6	0
132	3.3	-73.6	3.4	-75.6	2.0
134	3.2	-71.5	3.4	-75.6	4.1
136	3.3	-73.6	3.35	-74.6	1.0
138	3.4	-75.6	3.55	-78.9	3.3
140	3.1	-69.5	3.55	-78.9	9.4
		-1062.3		-1085.6	23.3

THE AVERAGE DIFFERENCE IN RECEIVED SIGNAL IS 1.6 dB.

LVS VOR

DIFFERENCE BETWEEN INBOUND AND OUTBOUND SIGNALS

DISTANCE	INBOUND AGC	INBOUND uV	INBOUND dBm	OUTBOUND AGC	OUTBOUND uV	OUTBOUND dBm	SIGNAL DIFFERENCE
110	6.45	37.8	-75.4	5.8	21	-80.7	5.3
112	-	-	-	TACAN UNLOCK			-
114	6.35	34	-76.3	5.7	19.8	-81.0	4.7
116	6.25	31	-77.2	5.55	17.4	-82.2	5.0
118	6.15	28	-78.0	5.45	16	-82.9	4.9
120	6.05	26	-78.7	5.3	14.4	-83.8	5.1
122	6.0	25	-79.0	5.2	13.4	-84.4	5.4
124	5.95	24	-79.4	4.7	9.3	-87.7	8.3
126	5.85	22	-80.3	4.6	8.5	-88.3	8.0
120	5.7	19.8	-81.0	4.55	8.1	-88.8	7.8
130	5.6	18.1	-81.8	4.45	7.4	-89.6	7.8
132	5.6	18.1	-81.8	4.4	7.1	-90.0	8.2
134	5.45	16.0	-82.9	4.4	7.1	-90.0	7.1
136	5.15	13.0	-84.7	4.5	7.8	-89.1	4.4
138	5.05	12.2	-85.0	4.4	7.1	-90.0	5.0
140	4.8	10.1	-86.9	4.3	6.5	-90.8	3.9
			-1208.4			-1299.3	90.9

THE AVERAGE DIFFERENCE IN RECEIVED SIGNAL IS 6.1 dB.

99

LVS TACAN

DIFFERENCE BETWEEN INBOUND AND OUTBOUND SIGNALS

DISTANCE	INBOUND AGC	INBOUND dBm	OUTBOUND AGC	OUTBOUND dBm	SIGNAL DIFFERENCE
110	3.15	-70.5	3.25	-72.6	2.1
112	3.3	-73.6	3.35	-74.6	1.0
114	2.85	-64.8	2.85	-64.8	0
116	2.75	-63	2.85	-64.8	1.8
118	2.9	-65.7	2.9	-65.7	0
120	3.05	-68.5	3.2	-71.5	3.0
122	3.05	-68.5	3.2	-71.5	3.0
124	3.2	-71.5	3.25	-72.6	1.1
126	3.2	-71.5	3.2	-71.5	0
128	2.9	-65.7	2.95	-66.6	0.9
130	2.65	-61	2.85	-64.8	3.8
132	2.8	-63.9	2.85	-64.8	0.9
134	2.8	-63.9	2.95	-66.6	2.7
136	2.8	-63.9	3.0	-67.5	3.6
138	2.8	-63.9	2.95	-66.6	2.7
140	2.9	-65.7	3.1	-69.5	3.8
		-1065.6		-1096.0	30.4

THE AVERAGE DIFFERENCE IN RECEIVED SIGNAL IS 1.9 dB.

100

ROW VOR

DIFFERENCE BETWEEN INBOUND AND OUTBOUND SIGNALS

DISTANCE	INBOUND AGC	INBOUND uV	INBOUND dBm	OUTBOUND AGC	OUTBOUND uV	OUTBOUND dBm	SIGNAL DIFFERENCE
110	6.15	28	-78.0	5.3	14.4	-83.8	5.8
112	6.1	27	-78.4	5.1	12.6	-84.9	6.5
114	6.05	26	-78.7	5.1	12.6	-84.9	6.2
116	6.05	26	-78.7	5.1	12.6	-84.9	6.2
118	6.0	25	-79.0	5.05	12.2	-85.0	6.0
120	5.95	24	-79.4	5.05	12.2	-85.0	5.6
122	5.9	23	-79.8	5.0	11.8	-85.6	5.8
124	5.85	22	-80.3	5.0	11.8	-85.6	5.3
126	5.8	21	-80.7	5.0	11.8	-85.6	4.9
128	5.7	19.8	-81.0	4.9	10.9	-85.2	5.2
130	5.6	18.1	-81.8	4.8	10.1	-86.9	5.1
132	5.45	16	-82.9	4.65	8.9	-88.0	5.1
134	5.4	15.3	-83.2	4.6	8.5	-88.3	5.1
136	5.4	15.3	-83.2	4.55	8.1	-88.8	5.6
138	5.3	14.4	-83.8	4.55	8.1	-88.8	5.0
140	5.25	13.9	-84.0	4.5	7.8	-89.1	5.1
			-1292.9			-1381.4	88.5

THE AVERAGE DIFFERENCE IN RECEIVED SIGNAL IS 5.5 dB.

101

AD-A053 265 FEDERAL AVIATION ADMINISTRATION WASHINGTON D C SYSTE--ETC F/G 17/7
A COMPARISON OF MEASURED DATA AND ITS MODEL PREDICTIONS.(U)
JAN 78 R D SMITH
UNCLASSIFIED FAA-RD-77-106 NL

2 OF 3
AD
A053265

ROW TACAN

DIFFERENCE BETWEEN INBOUND AND OUTBOUND SIGNALS

DISTANCE	INBOUND AGC	INBOUND dBm	OUTBOUND AGC	OUTBOUND dBm	SIGNAL DIFFERENCE
110	2.8	-63.9	2.9	-65.7	1.8
112	2.9	-65.7	2.95	-66.6	0.9
114	2.8	-63.9	3.05	-68.5	4.6
116	2.9	-65.7	3.05	-68.5	2.8
118	2.95	-66.6	3.1	-69.5	2.9
120	3.0	-67.5	3.15	-70.5	3.0
122	2.95	-66.6	3.1	-69.5	2.9
124	3.15	-70.5	3.25	-72.6	2.1
126	3.1	-69.5	3.5	-77.7	8.2
128	3.45	-76.6	3.3	-73.6	-3.0
130	3.2	-71.5	3.6	-80.0	8.5
132	3.2	-71.5	3.25	-72.6	1.1
134	3.2	-71.5	3.4	-75.6	4.1
136	3.45	-76.6	3.4	-75.6	-1.0
138	3.3	-73.6	3.3	-73.6	0
140	3.25	-72.6	3.3	-73.6	1.0
		-1113.8		-1153.7	39.9

THE AVERAGE DIFFERENCE IN RECEIVED SIGNAL IS 2.5 dB.

102

TCC VOR

DIFFERENCE BETWEEN INBOUND AND OUTBOUND SIGNALS

	INBOUND			OUTBOUND			SIGNAL
DISTANCE	AGC	uV	dBm	AGC	uV	dBm	DIFFERENCE
110	-	-	-	AIRCRAFT TURNING			-
112	5.8	21	-80.7	5.3	14.4	-83.8	3.1
114	5.7	19.8	-81.0	5.2	13.4	-84.4	3.4
116	5.65	19	-81.4	5.1	12.6	-84.9	3.5
118	5.6	18.1	-81.8	5.05	12.2	-85.0	3.2
120	5.55	17.4	-82.2	4.75	9.7	-87.3	5.1
122	5.55	17.4	-82.2	4.7	9.3	-87.7	5.5
124	5.45	16	-82.9	4.6	8.5	-88.3	5.4
126	5.35	14.9	-83.6	4.5	7.8	-89.1	5.5
128	5.3	14.4	-83.8	4.4	7.1	-90.0	6.2
130	5.2	13.4	-84.4	4.4	7.1	-90.0	5.6
132	4.9	10.9	-86.2	4.4	7.1	-90.0	3.8
134	4.85	10.5	-86.5	4.3	6.5	-90.8	4.3
136	4.7	9.3	-87.7	4.25	6.2	-91.2	3.5
138	4.55	8.1	-88.8	4.2	5.9	-91.5	2.7
140	4.4	7.1	-90.0	4.1	5.3	-92.5	2.5
			-1263.2			-1326.5	63.3

THE AVERAGE DIFFERENCE IN RECEIVED SIGNAL IS 4.2 dB.

103

TCC TACAN

DIFFERENCE BETWEEN INBOUND AND OUTBOUND SIGNALS

DISTANCE	INBOUND AGC	INBOUND dBm	OUTBOUND AGC	OUTBOUND dBm	SIGNAL DIFFERENCE
110	-	-	AIRCRAFT TURNING		-
112	2.4	-56.5	2.5	-58.2	1.7
114	2.45	-57.3	2.6	-60	2.7
116	2.4	-56.5	2.5	-58.5	1.7
118	2.4	-56.5	2.65	-61	4.5
120	2.6	-60	2.7	-62	2.0
122	2.45	-57.3	2.75	-63	5.7
124	2.75	-63	2.8	-63.9	0.9
126	2.65	-61	2.85	-64.8	3.8
128	2.8	-63.9	2.95	-66.6	2.7
130	3.0	-67.5	2.95	-66.6	-0.9
132	2.85	-64.8	2.85	-64.8	0
134	3.6	-80	3.1	-69.5	-10.5
136	3.05	-68.5	3.45	-76.6	8.1
138	2.8	-63.9	2.95	-66.6	2.7
140	2.95	-66.6	2.85	-64.8	-1.8
		-943.3		-966.6	23.3

THE AVERAGE DIFFERENCE IN RECEIVED SIGNAL IS 1.6 dB.

104

APPENDIX E
I.T.S. COMPUTER MODEL OUTPUTS

The predicted data in Appendixes A and C are based on the computer outputs given in this Appendix. Predictions were made assuming general variability, 4/3 smooth earth. With this assumption and with similarities from site to site, it was not necessary to run 20 graphs for VOR and 20 graphs for TACAN. Only 5 VOR graphs and 3 TACAN graphs were necessary. Minor adjustments to the predictions were required in order to use the same graph for several facilities with slightly different transmitter powers. These adjustments are shown in Table E-1.

In calculating the EIRP of the TACAN facilities, an RTA-2 antenna with a mainbeam gain of 7.4 dBi was assumed. For all but the mountain top facility, cable loss of 1.0 dB was assumed. For the mountain top facility (CIM), an additional cable loss of 3.0 dB was assumed for a total of 4.0 dB loss at this one site.

In calculating the EIRP of the VOR facilities, a mainbeam antenna gain of 2.2 dBi was assumed for all facilities. For all but the mountain top facility, cable loss of 3.0 dB was assumed. For the mountain top facility (CIM), an additional cable loss of 3.0 dB was assumed for a total of 6.0 dB loss at this site.

105

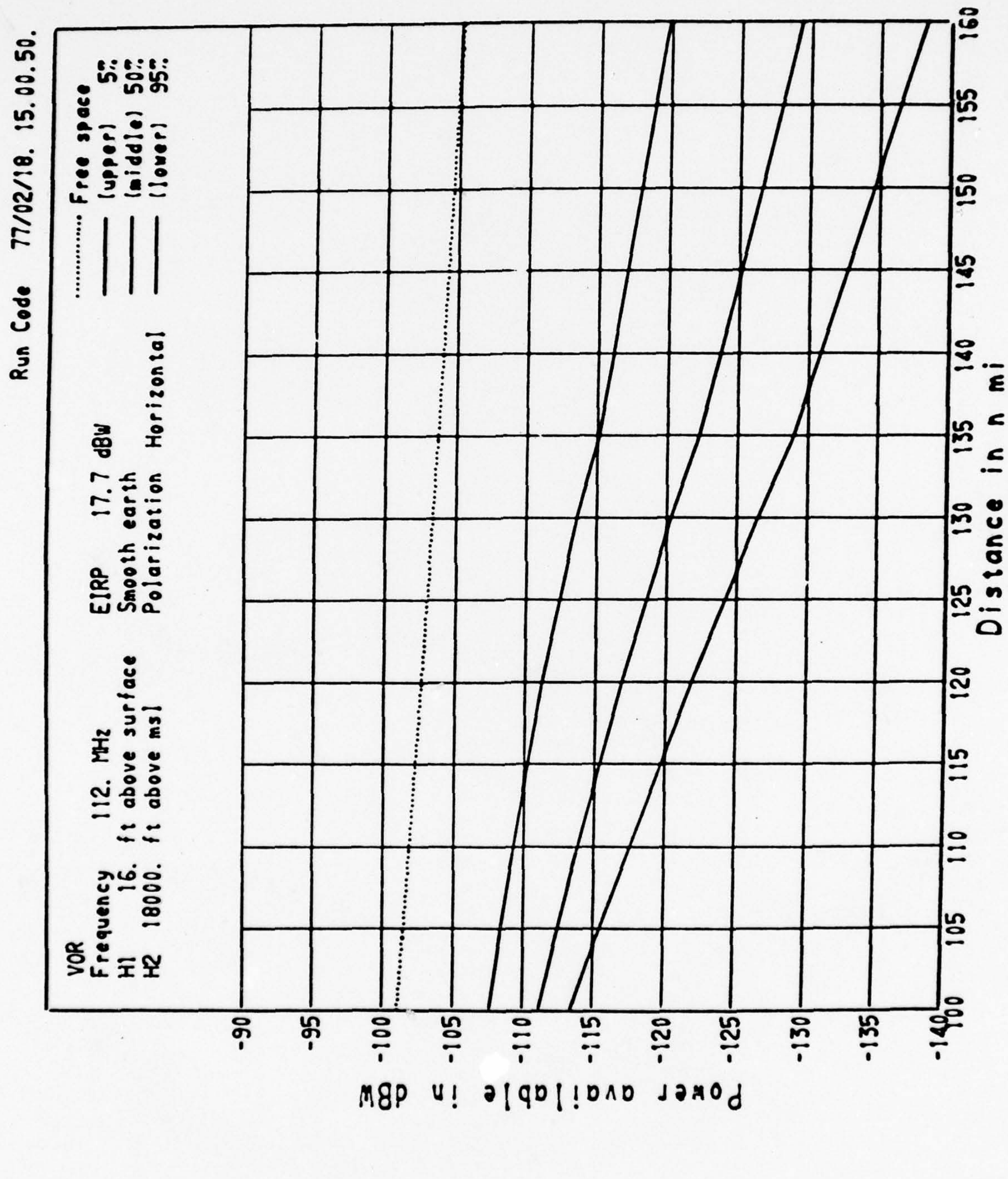

Run Code 77/02/18. 15.00.50.
VOR
Frequency 112. MHz
H1 16. ft above surface
H2 18000. ft above msl
EIRP 17.7 dBW
Smooth earth
Polarization Horizontal
Free space
(upper) 5%
(middle) 50%
(lower) 95%
Power available in dBW
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
100
105
110
115
120
125
130
135
140
145
150
155
160
Distance in n mi

FIGURE E 1

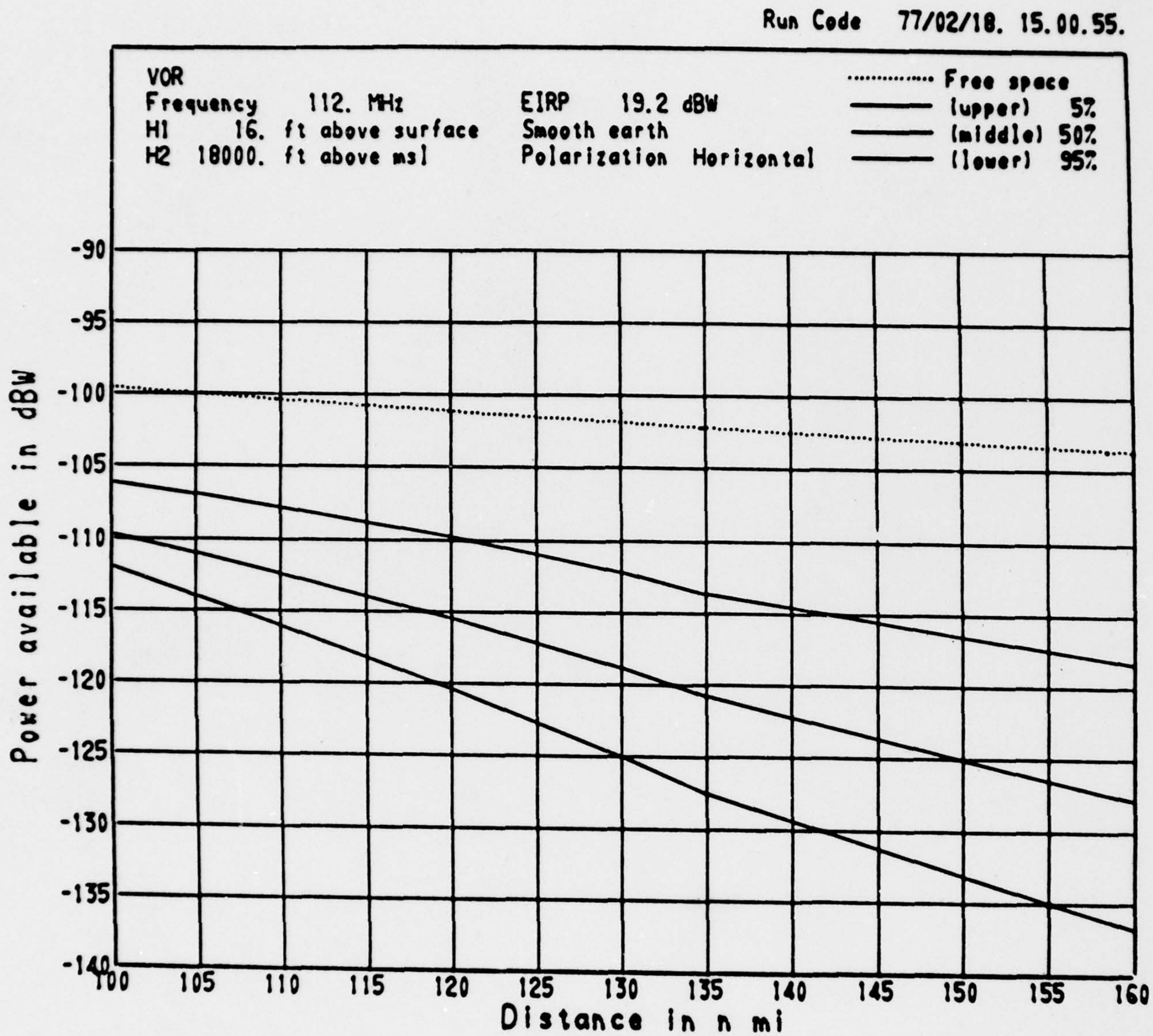
```
PARAMETERS FOR ITS PROPAGATION MODEL  FEB 76
77/02/18.   15.00.50. RUN

POWER AVAILABLE FOR VOR
REQUIRED OR FIXED
------------------
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  18000. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:     16.0 FT ABOVE SITE SURFACE
FREQUENCY:  112. MHZ

SPECIFICATION OPTIONAL
-----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: HORIZONTAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:      0. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:    17.7 DBW
FACILITY ANTENNA TYPE:  4-LOOP ARRAY (COSINE VERTICAL PATTERN)
     POLARIZATION: HORIZONTAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:    4.91 N MI FROM FACILITY*
     ELEVATION ANGLE:    -0/ 3/41 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT:      0. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4586. N MI*
     MINIMUM MONTHLY MEAN :301. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE:    0. FT ABOVE MSL
TERRAIN PARAMETER:   0. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


* COMPUTED VALUE
```

107



Run Code 77/02/18. 15.00.55.
VOR
Frequency 112. MHz
H1 16. ft above surface
H2 18000. ft above msl
EIRP 19.2 dBW
Smooth earth
Polarization Horizontal
Free space
(upper) 5%
(middle) 50%
(lower) 95%
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
Power available in dBW
100
105
110
115
120
125
130
135
140
145
150
155
160
Distance in n mi

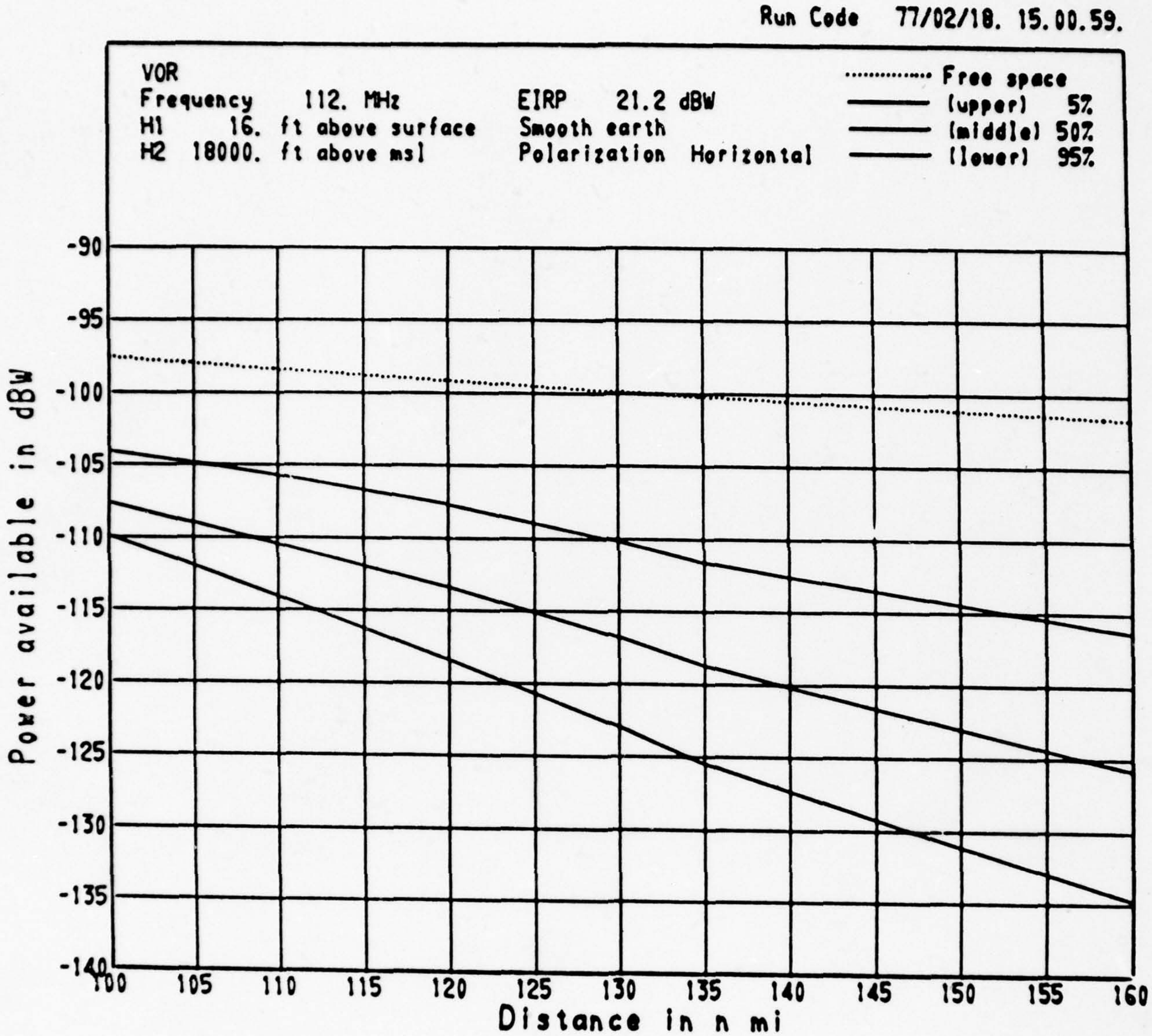
FIGURE E 2

```
        PARAMETERS FOR ITS PROPAGATION MODEL   FEB 76
                  77/02/18.   15.00.55. RUN

                      POWER AVAILABLE FOR VOR
                     REQUIRED OR FIXED
                     -----------------
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  18000. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:     16.0 FT ABOVE SITE SURFACE
FREQUENCY:  112. MHZ

                  SPECIFICATION OPTIONAL
                  ----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: HORIZONTAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:      0. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   19.2 DBW
FACILITY ANTENNA TYPE:  4-LOOP ARRAY (COSINE VERTICAL PATTERN)
     POLARIZATION: HORIZONTAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:   4.91 N MI FROM FACILITY*
     ELEVATION ANGLE:   -0/ 3/41 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT:     0. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4586. N MI*
     MINIMUM MONTHLY MEAN :301. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE:    0. FT ABOVE MSL
TERRAIN PARAMETER:   0. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


* COMPUTED VALUE
```



Run Code 77/02/18. 15.00.59.
VOR
Frequency 112. MHz
H1 16. ft above surface
H2 18000. ft above msl
EIRP 21.2 dBW
Smooth earth
Polarization Horizontal
Free space
(upper) 5%
(middle) 50%
(lower) 95%
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
Power available in dBW
100
105
110
115
120
125
130
135
140
145
150
155
160
Distance in n mi

FIGURE E 3

PARAMETERS FOR ITS PROPAGATION MODEL FEB 76
77/02/18. 15.00.53. RUN

POWER AVAILABLE FOR VOR
REQUIRED OR FIXED

AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE: 18000. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT: 16.0 FT ABOVE SITE SURFACE
FREQUENCY: 112. MHZ

SPECIFICATION OPTIONAL

AIRCRAFT ANTENNA TYPE: ISOTROPIC
POLARIZATION: HORIZONTAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL: 0. FT
EI-P PLUS RECEIVING ANTENNA MAIN BEAM GAIN: 21.2 DBW
FACILITY ANTENNA TYPE: 4-LOOP ARRAY (COSINE VERTICAL PATTERN)
POLARIZATION: HORIZONTAL
COUNTERPOISE DIAMETER: 52. FT
HEIGHT: 12. FT ABOVE SITE SURFACE
SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE: 4.91 N MI FROM FACILITY*
ELEVATION ANGLE: -0/ 3/41 DEG/MIN/SEC ABOVE HORIZONTAL*
HEIGHT: 0. FT ABOVE MSL
REFRACTIVITY:
EFFECTIVE EARTH RADIUS: 4586. N MI*
MINIMUM MONTHLY MEAN :301. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING: CONTRIBUTES TO VARIABILITY
SURFACE TYPE: AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 0. FT ABOVE MSL
TERRAIN PARAMETER: 0. FT
TIME AVAILABILITY: FOR INSTANTANEOUS LEVELS EXCEEDED

* COMPUTED VALUE

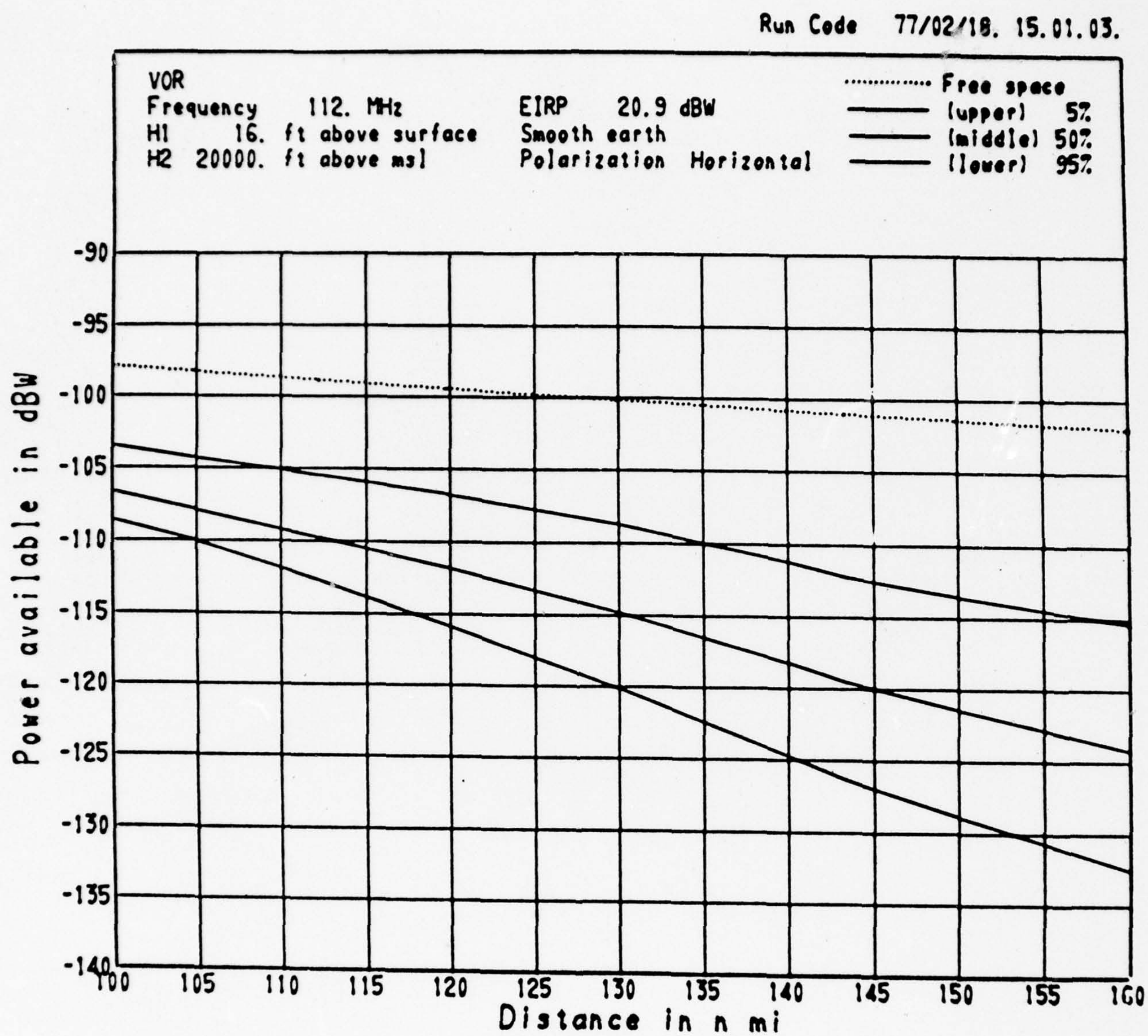

Run Code 77/02/18. 15.01.03.
VOR
Frequency 112. MHz
H1 16. ft above surface
H2 20000. ft above msl
EIRP 20.9 dBW
Smooth earth
Polarization Horizontal
Free space
(upper) 5%
(middle) 50%
(lower) 95%
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
100
105
110
115
120
125
130
135
140
145
150
155
160
Power available in dBW
Distance in n mi

FIGURE E 4

PARAMETERS FOR ITS PROPAGATION MODEL FEB 76
77/02/18. 15.01.03. RUN

POWER AVAILABLE FOR VOR
REQUIRED OR FIXED

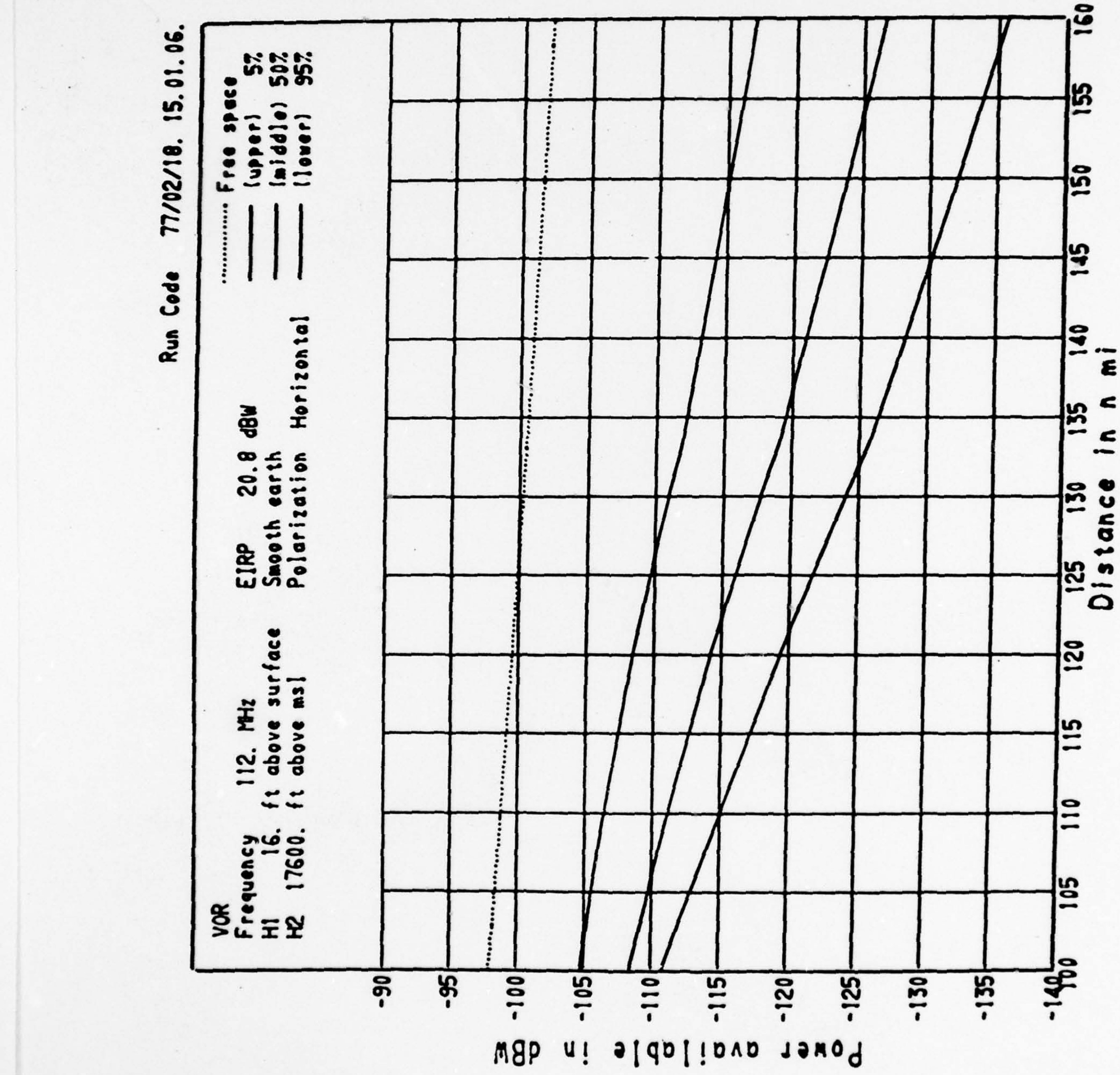
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE: 20000. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT: 16.0 FT ABOVE SITE SURFACE
FREQUENCY: 112. MHZ

SPECIFICATION OPTIONAL

AIRCRAFT ANTENNA TYPE: ISOTROPIC
POLARIZATION: HORIZONTAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL: 0. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN: 20.9 DBW
FACILITY ANTENNA TYPE: 4-LOOP ARRAY (COSINE VERTICAL PATTERN)
POLARIZATION: HORIZONTAL
COUNTERPOISE DIAMETER: 52. FT
HEIGHT: 12. FT ABOVE SITE SURFACE
SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE: 4.91 N MI FROM FACILITY*
ELEVATION ANGLE: -0/ 3/41 DEG/MIN/SEC ABOVE HORIZONTAL*
HEIGHT: 0. FT ABOVE MSL
REFRACTIVITY:
EFFECTIVE EARTH RADIUS: 4586. N MI*
MINIMUM MONTHLY MEAN :301. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING: CONTRIBUTES TO VARIABILITY
SURFACE TYPE: AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 0. FT ABOVE MSL
TERRAIN PARAMETER: 0. FT
TIME AVAILABILITY: FOR INSTANTANEOUS LEVELS EXCEEDED

* COMPUTED VALUE

113



Run Code 77/02/18. 15.01.06.
VOR
Frequency 112. MHz
H1 16. ft above surface
H2 17600. ft above msl
EIRP 20.8 dBW
Smooth earth
Polarization Horizontal
Free space
(upper) 5%
(middle) 50%
(lower) 95%
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
100
105
110
115
120
125
130
135
140
145
150
155
160
Power available in dBW
Distance in n mi

FIGURE E 5

PARAMETERS FOR ITS PROPAGATION MODEL FEB 76
77/02/18. 15.01.06. RUN

POWER AVAILABLE FOR VOR
REQUIRED OR FIXED

```
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  17600. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:     16.0 FT ABOVE SITE SURFACE
FREQUENCY:  112. MHZ
```

SPECIFICATION OPTIONAL

```
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: HORIZONTAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:      0. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   20.8 DBW
FACILITY ANTENNA TYPE:  4-LOOP ARRAY (COSINE VERTICAL PATTERN)
     POLARIZATION: HORIZONTAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:   4.91 N MI FROM FACILITY*
     ELEVATION ANGLE:   -0/ 3/41 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT:    0. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4586. N MI*
     MINIMUM MONTHLY MEAN :301. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE:    0. FT ABOVE MSL
TERRAIN PARAMETER:   0. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED
```

* COMPUTED VALUE

115

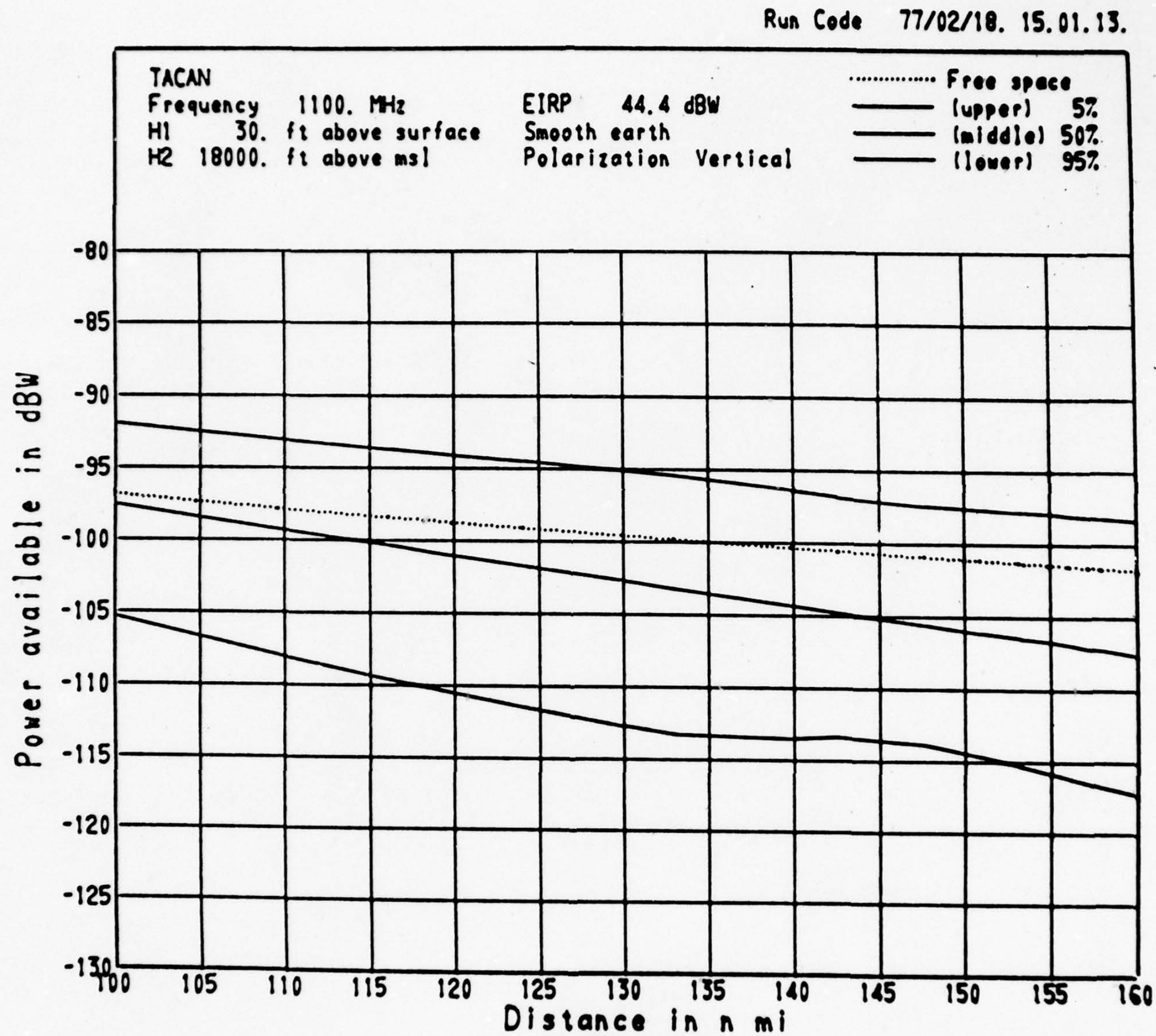

Run Code 77/02/18. 15.01.13.
TACAN
Frequency 1100. MHz
H1 30. ft above surface
H2 18000. ft above msl
EIRP 44.4 dBW
Smooth earth
Polarization Vertical
Free space
(upper) 5%
(middle) 50%
(lower) 95%
-80
-85
-90
-95
-100
-105
-110
-115
-120
-125
-130
100
105
110
115
120
125
130
135
140
145
150
155
160
Power available in dBW
Distance in n mi

FIGURE E 6

PARAMETERS FOR ITS PROPAGATION MODEL FEB 76
77/02/18. 15.01.13. RUN

POWER AVAILABLE FOR TACAN
REQUIRED OR FIXED

AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE: 18000. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT: 30.0 FT ABOVE SITE SURFACE
FREQUENCY: 1100. MHZ

SPECIFICATION OPTIONAL

AIRCRAFT ANTENNA TYPE: ISOTROPIC
POLARIZATION: VERTICAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL: 0. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN: 44.4 DBW
FACILITY ANTENNA TYPE: TACAN (RTA-2)
POLARIZATION: VERTICAL
COUNTERPOISE DIAMETER: 52. FT
HEIGHT: 12. FT ABOVE SITE SURFACE
SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE: 6.73 N MI FROM FACILITY*
ELEVATION ANGLE: -0/ 5/ 2 DEG/MIN/SEC ABOVE HORIZONTAL*
HEIGHT: 0. FT ABOVE MSL
REFRACTIVITY:
EFFECTIVE EARTH RADIUS: 4586. N MI*
MINIMUM MONTHLY MEAN :301. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING: CONTRIBUTES TO VARIABILITY
SURFACE TYPE: AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 0. FT ABOVE MSL
TERRAIN PARAMETER: 0. FT
TIME AVAILABILITY: FOR INSTANTANEOUS LEVELS EXCEEDED

* COMPUTED VALUE

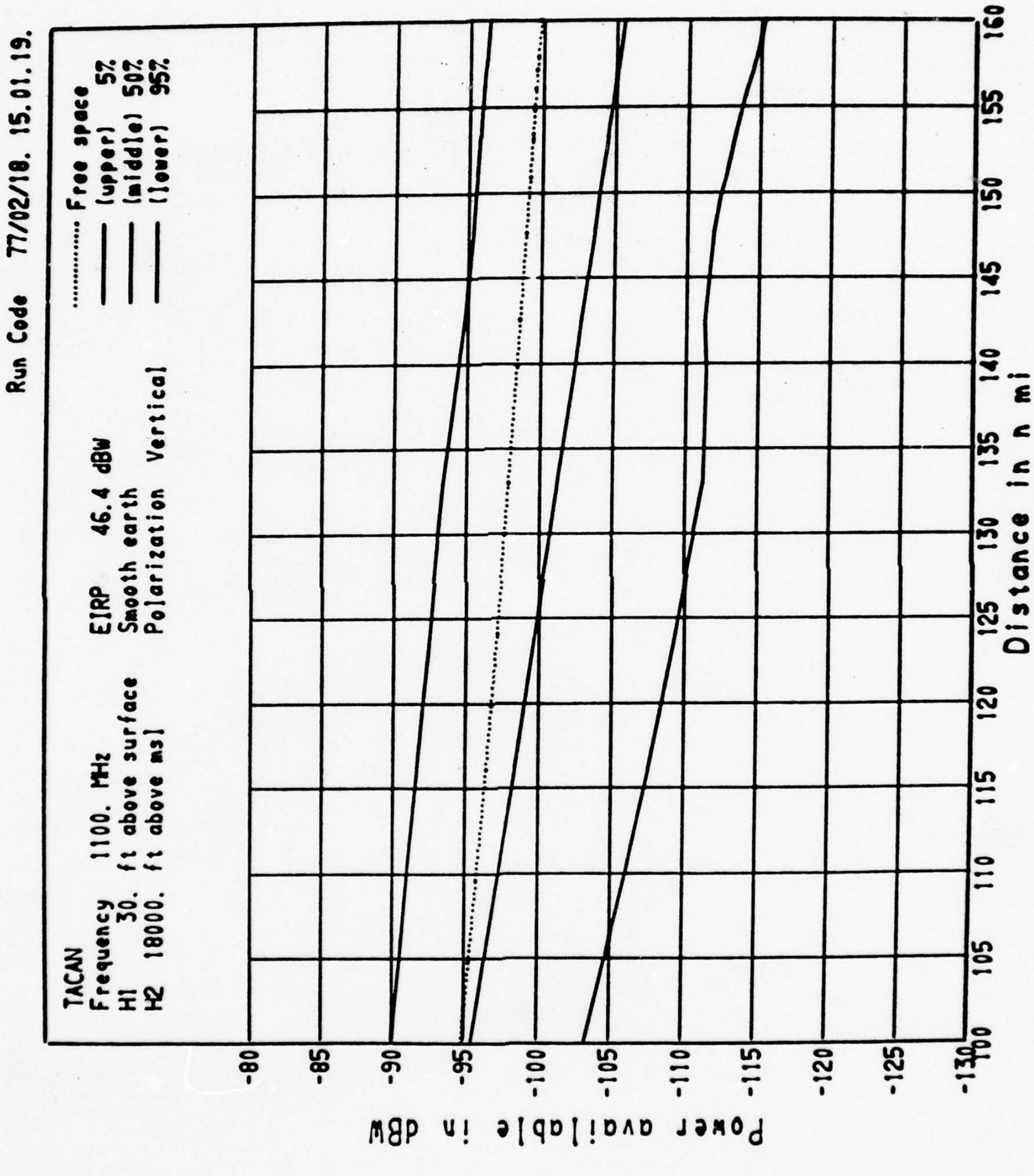

Run Code 77/02/18. 15.01.19.
TACAN
Frequency 1100. MHz
H1 30. ft above surface
H2 18000. ft above msl
EIRP 46.4 dBW
Smooth earth
Polarization Vertical
Free space
(upper) 5%
(middle) 50%
(lower) 95%
Power available in dBW
-80
-85
-90
-95
-100
-105
-110
-115
-120
-125
-130
100
105
110
115
120
125
130
135
140
145
150
155
160
Distance in n mi

FIGURE E 7

```
PARAMETERS FOR ITS PROPAGATION MODEL  FEB 76
        77/02/18.   15.01.19. RUN

                POWER AVAILABLE FOR TACAN
                REQUIRED OR FIXED
                -----------------
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  18000. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:     30.0 FT ABOVE SITE SURFACE
FREQUENCY: 1100. MHZ

              SPECIFICATION OPTIONAL
              ----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: VERTICAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:      0. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   46.4 DBW
FACILITY ANTENNA TYPE:  TACAN (RTA-2)
     POLARIZATION: VERTICAL
     COUNTERPOISE DIAMETER:  52. FT
           HEIGHT:  12. FT ABOVE SITE SURFACE
           SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:    6.73 N MI FROM FACILITY*
     ELEVATION ANGLE:   -0/ 5/ 2 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT:     0. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4586. N MI*
     MINIMUM MONTHLY MEAN :301. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE:     0. FT ABOVE MSL
TERRAIN PARAMETER:    0. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


* COMPUTED VALUE
```

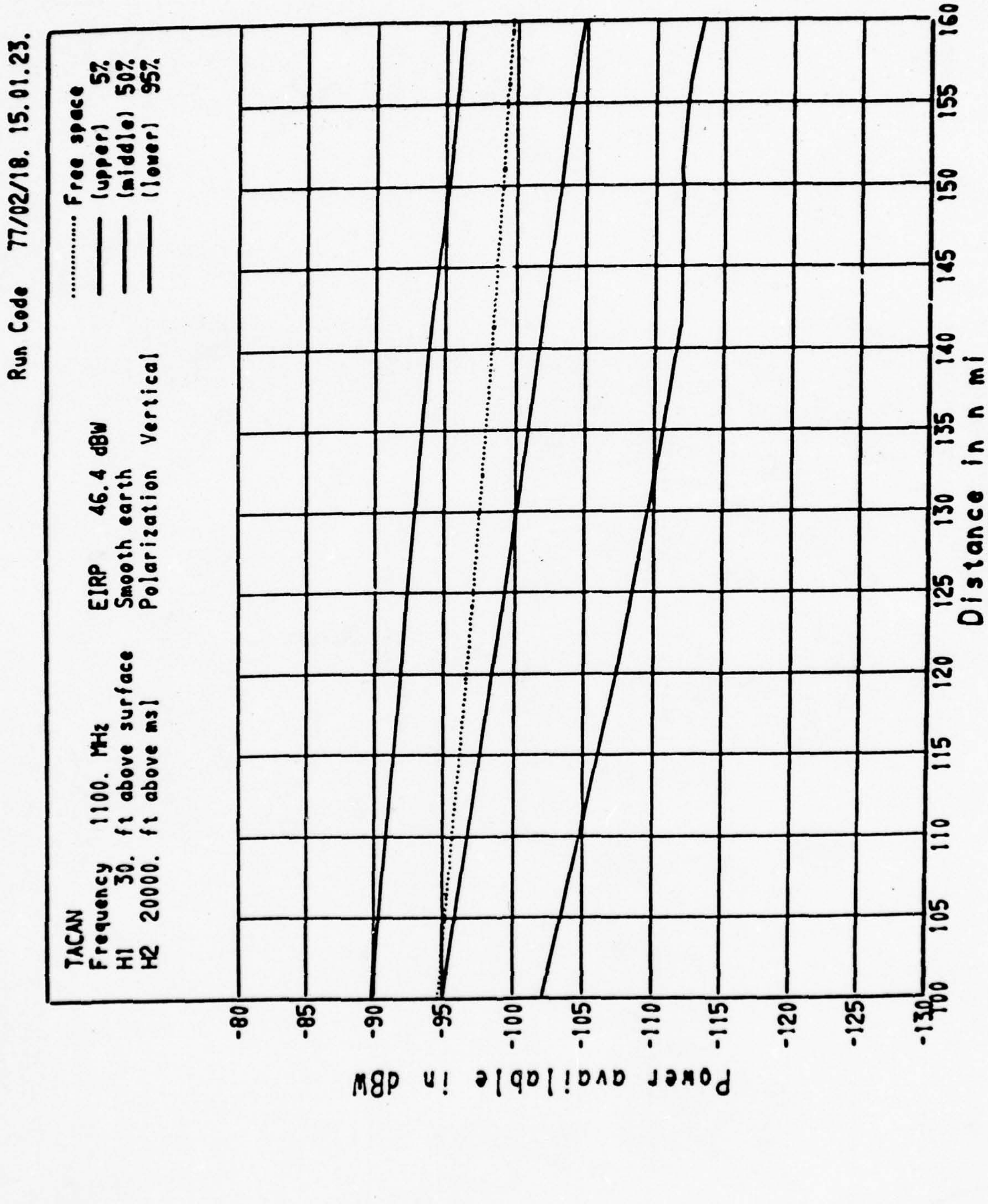

TACAN
Frequency 1100. MHz
H1 30. ft above surface
H2 20000. ft above msl
EIRP 46.4 dBW
Smooth earth
Polarization Vertical
Run Code 77/02/18. 15.01.23.
Free space
(upper) 5%
(middle) 50%
(lower) 95%
Power available in dBW
Distance in n mi
-80
-85
-90
-95
-100
-105
-110
-115
-120
-125
-130
100
105
110
115
120
125
130
135
140
145
150
155
160

FIGURE E 8

PARAMETERS FOR ITS PROPAGATION MODEL FEB 76
77/02/18. 15.01.23. RUN

POWER AVAILABLE FOR TACAN
REQUIRED OR FIXED

AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE: 20000. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT: 30.0 FT ABOVE SITE SURFACE
FREQUENCY: 1100. MHZ

SPECIFICATION OPTIONAL

AIRCRAFT ANTENNA TYPE: ISOTROPIC
POLARIZATION: VERTICAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL: 0. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN: 46.4 DBW
FACILITY ANTENNA TYPE: TACAN (RTA-2)
POLARIZATION: VERTICAL
COUNTERPOISE DIAMETER: 52. FT
HEIGHT: 12. FT ABOVE SITE SURFACE
SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE: 6.73 N MI FROM FACILITY*
ELEVATION ANGLE: -0/ 5/ 2 DEG/MIN/SEC ABOVE HORIZONTAL*
HEIGHT: 0. FT ABOVE MSL
REFRACTIVITY:
EFFECTIVE EARTH RADIUS: 4586. N MI*
MINIMUM MONTHLY MEAN :301. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING: CONTRIBUTES TO VARIABILITY
SURFACE TYPE: AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 0. FT ABOVE MSL
TERRAIN PARAMETER: 0. FT
TIME AVAILABILITY: FOR INSTANTANEOUS LEVELS EXCEEDED

* COMPUTED VALUE

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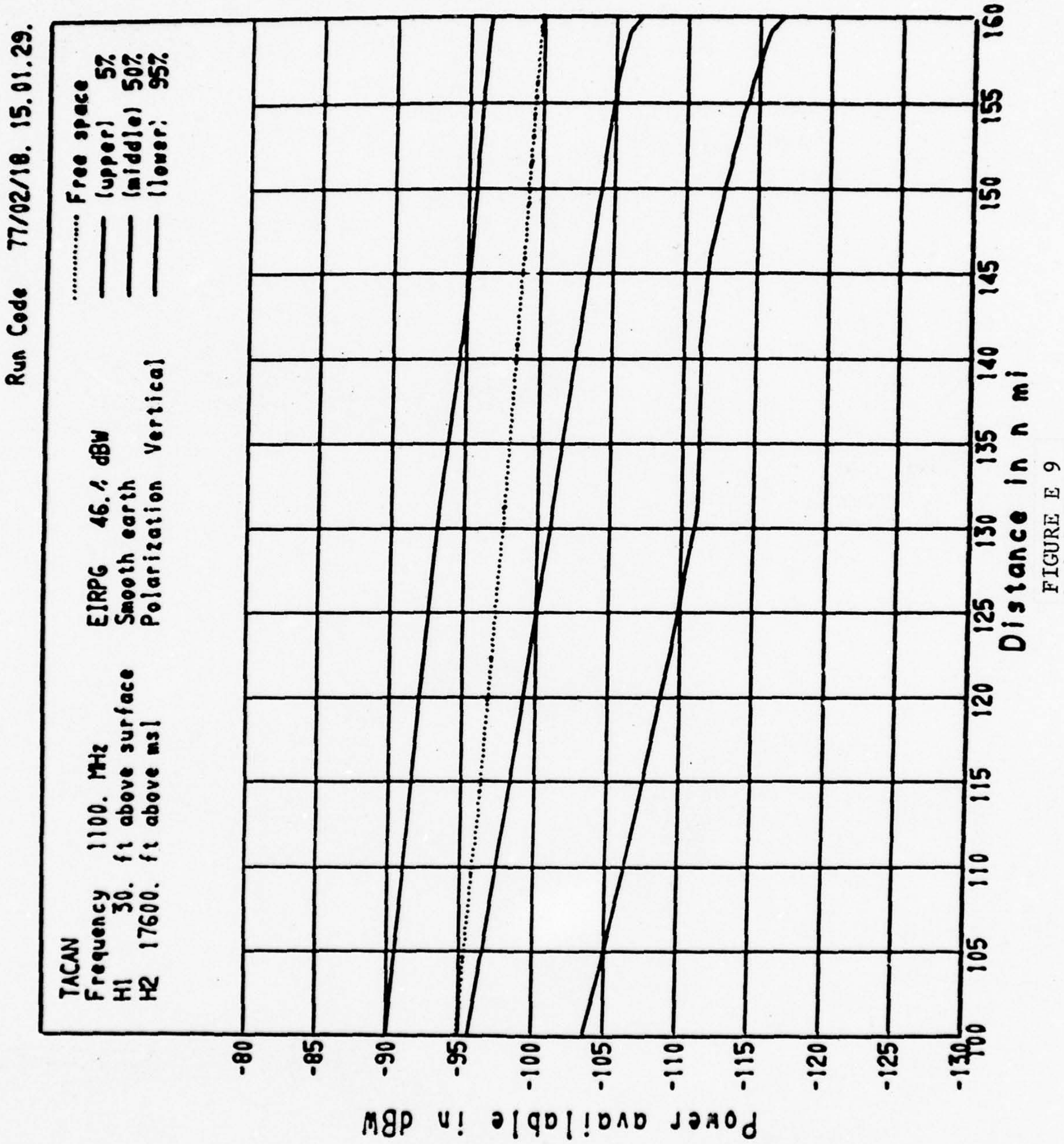
TACAN
Frequency 1100. MHz
H1 30. ft above surface
H2 17600. ft above msl
EIRPG 46.7 dBW
Smooth earth
Polarization Vertical
Run Code 77/02/18. 15.01.29.
Free space
(upper) 5%
(middle) 50%
(lower) 95%
-80
-85
-90
-95
-100
-105
-110
-115
-120
-125
-130
100
105
110
115
120
125
130
135
140
145
150
155
160
Distance in n mi
Power available in dBW

FIGURE E 9

PARAMETERS FOR ITS PROPAGATION MODEL FEB 76
77/02/18. 15.01.29. FUN

POWER AVAILABLE FOR TACAN
REQUIRED OR FIXED

AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE: 17600. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT: 30.0 FT ABOVE SITE SURFACE
FREQUENCY: 1100. MHZ

SPECIFICATION OPTIONAL

AIRCRAFT ANTENNA TYPE: ISOTROPIC
    POLARIZATION: VERTICAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL: 0. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN: 46.4 DBW
FACILITY ANTENNA TYPE: TACAN (RTA-2)
    POLARIZATION: VERTICAL
    COUNTERPOISE DIAMETER: 52. FT
        HEIGHT: 12. FT ABOVE SITE SURFACE
        SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE: 6.73 N MI FROM FACILITY*
    ELEVATION ANGLE: -0/ 5/ 2 DEG/MIN/SEC ABOVE HORIZONTAL*
    HEIGHT: 0. FT ABOVE MSL
REFRACTIVITY:
    EFFECTIVE EARTH RADIUS: 4586. N MI*
    MINIMUM MONTHLY MEAN :301. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING: CONTRIBUTES TO VARIABILITY
SURFACE TYPE: AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 0. FT ABOVE MSL
TERRAIN PARAMETER: 0. FT
TIME AVAILABILITY: FOR INSTANTANEOUS LEVELS EXCEEDED

* COMPUTED VALUE

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TABLE E-1

ADJUSTMENTS MADE TO ITS GRAPHS IN ORDER TO ACCOUNT FOR SLIGHT DIFFERENCES IN POWER

		VOR		TACAN	
	IDENT	ITS GRAPH	ADJUSTMENT	ITS GRAPH	ADJUSTMENT
Abilene, Tx.	ABI	15.00.55	+1.5 dB	15.01.19	0 dB
Albuquerque, N.M.	ABQ	15.00.55	+1.0 dB	15.01.13	-1.4 dB
Amarillo, Tx.	AMA	15.00.55	0 dB	15.01.13	-1.8 dB
Cimarron, N.M. (Mt. Top)	CIM	15.00.50	0 dB	15.01.13	-1.0 dB
El Paso, Tx.	ELP	15.00.55	+1.6 dB	15.01.19	0 dB
Greater Southwest, Tx.	GSW	15.00.59	-0.2 dB	15.01.13	-1.9 dB
Junction, Tx.	JCT	15.00.55	+1.1 dB	15.01.19	0 dB
Las Vegas, N.M.	LVS	15.00.55	+0.8 dB	15.01.13	-2.0 dB
Millsap, Tx.	MQP	15.00.55	+1.1 dB	15.01.13	-0.8 dB
Oklahoma City, OK	OKC	15.00.59	-0.5 dB	15.01.13	-1.0 dB
Pioneer, OK	PER	15.00.55	0 dB	15.01.13	-1.8 dB
Roswell, N.M.	ROW	15.01.06	-0.7 dB	15.01.29	0 dB
San Angelo, Tx.	SJT	15.00.59	-0.4 dB	15.01.19	-0.5 dB
San Antonio, Tx.	SAT	15.00.59	-0.5 dB	15.01.13	-1.7 dB
Texico, Tx.	TXO	15.00.59	-0.3 dB	15.01.19	0 dB
Truth or Consequences, N.M.	TSC	15.00.55	+0.7 dB	15.01.19	-0.1 dB
Tucumcari, N.M.	TCC	15.00.59	-0.7 dB	15.01.19	-0.2 dB
Tulsa, OK.	TUL	15.00.55	+0.6 dB	15.01.13	-0.2 dB
Waco, Tx.	ACT	15.00.59	-0.2 dB	15.01.13	-0.2 dB
Wink, Tx.	INK	15.01.03	0 dB	15.01.23	0 dB

NOTE: The ITS graphs are identified by a twelve digit run code. Only the last six digits are shown above. For these graphs, the first six digits are 77/02/18.

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APPENDIX F

TERRAIN PROFILE SHOWING LINE OF SIGHT FOR THE FLIGHT LEVEL AT EACH FACILITY

Using the ECAC terrain file, terrain profiles were made for the particular azimuth flown at each facility. Using these profiles, the line of sight distances can be determined for the particular flight level flown on each radial. This is shown in Figures F 1 through F 40. Of the twenty facilities tested, it appears that data was collected beyond line of sight only at Abilene, Tx. and Trugh or Consequencies, N.M.

Table F-1 on page F-42 gives the horizen parameters for the radial flown at each of the sites. The values were taken from the digital computer printout on which figures F 1 through F 40 were based.

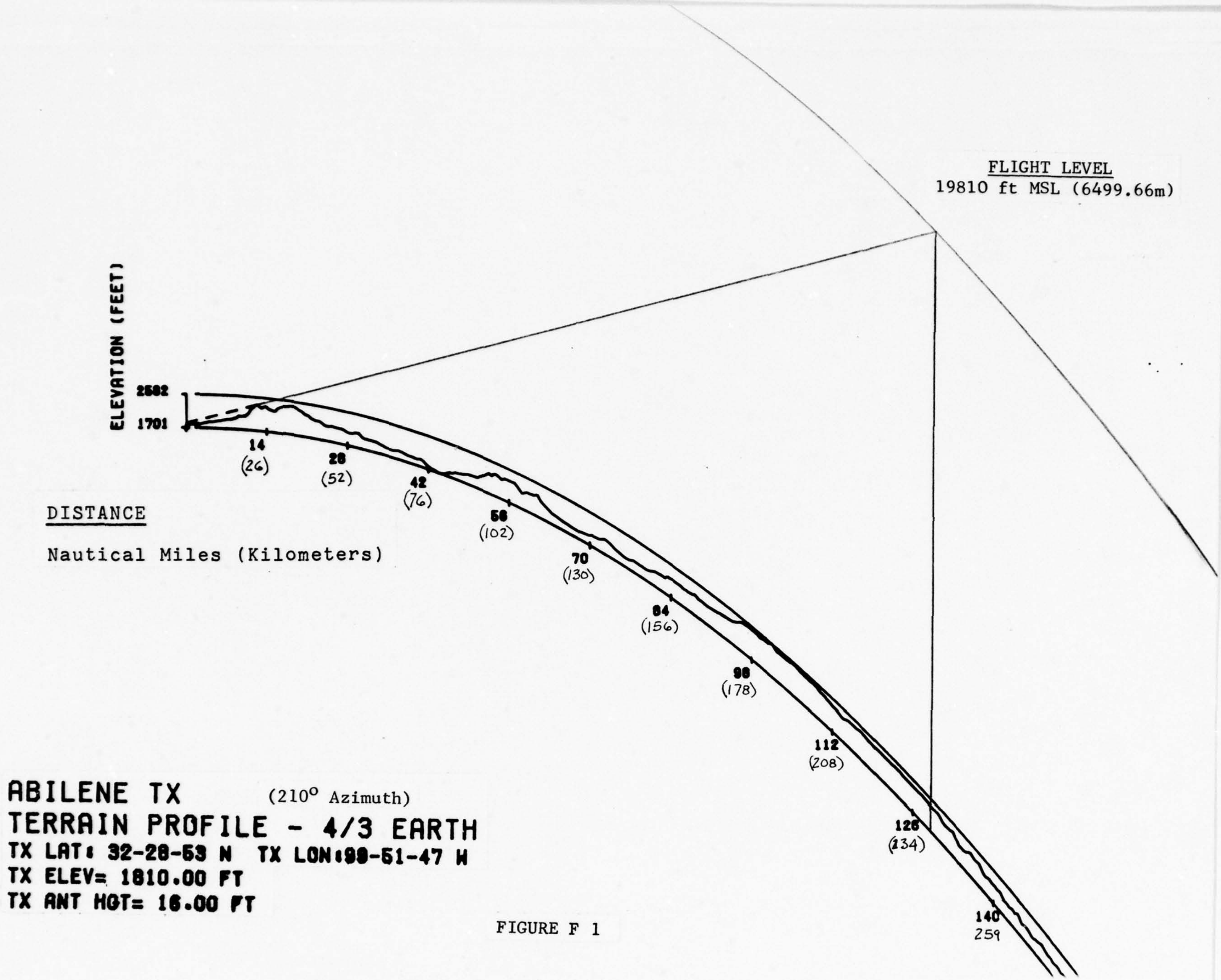
FLIGHT LEVEL
19810 ft MSL (6499.66m)
ELEVATION (FEET)
2582
1701
14 (26)
28 (52)
42 (76)
56 (102)
70 (130)
84 (156)
98 (178)
112 (208)
126 (234)
140 259
DISTANCE
Nautical Miles (Kilometers)
ABILENE TX (210° Azimuth)
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 32-28-53 N TX LON:99-51-47 W
TX ELEV= 1810.00 FT
TX ANT HGT= 16.00 FT

FIGURE F 1

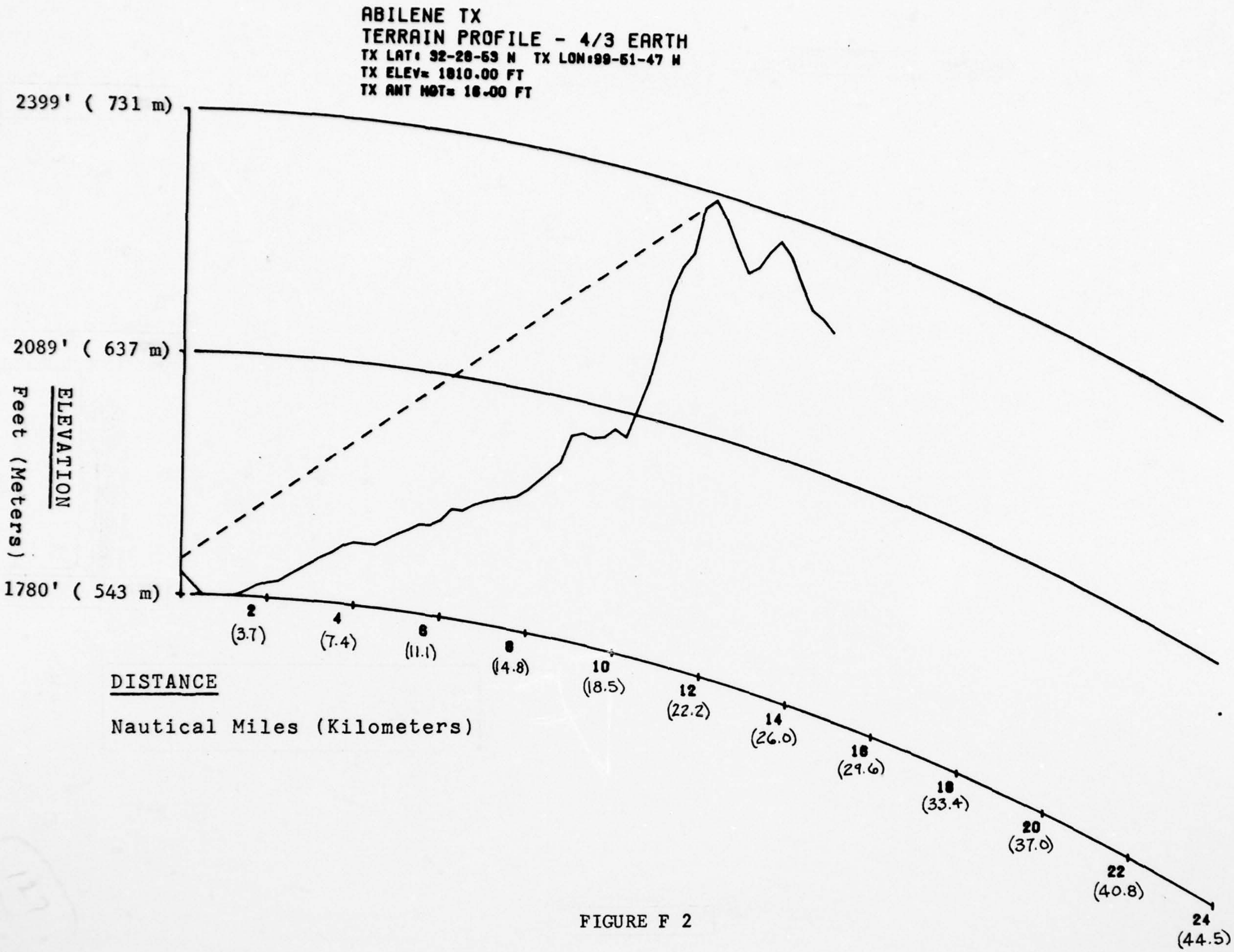
ABILENE TX
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 32-28-53 N TX LON:99-51-47 W
TX ELEV= 1810.00 FT
TX ANT HGT= 16.00 FT
2399' (731 m)
2089' (637 m)
1780' (543 m)
ELEVATION
Feet (Meters)
2 (3.7)
4 (7.4)
6 (11.1)
8 (14.8)
10 (18.5)
12 (22.2)
14 (26.0)
16 (29.6)
18 (33.4)
20 (37.0)
22 (40.8)
24 (44.5)
DISTANCE
Nautical Miles (Kilometers)

FIGURE F 2

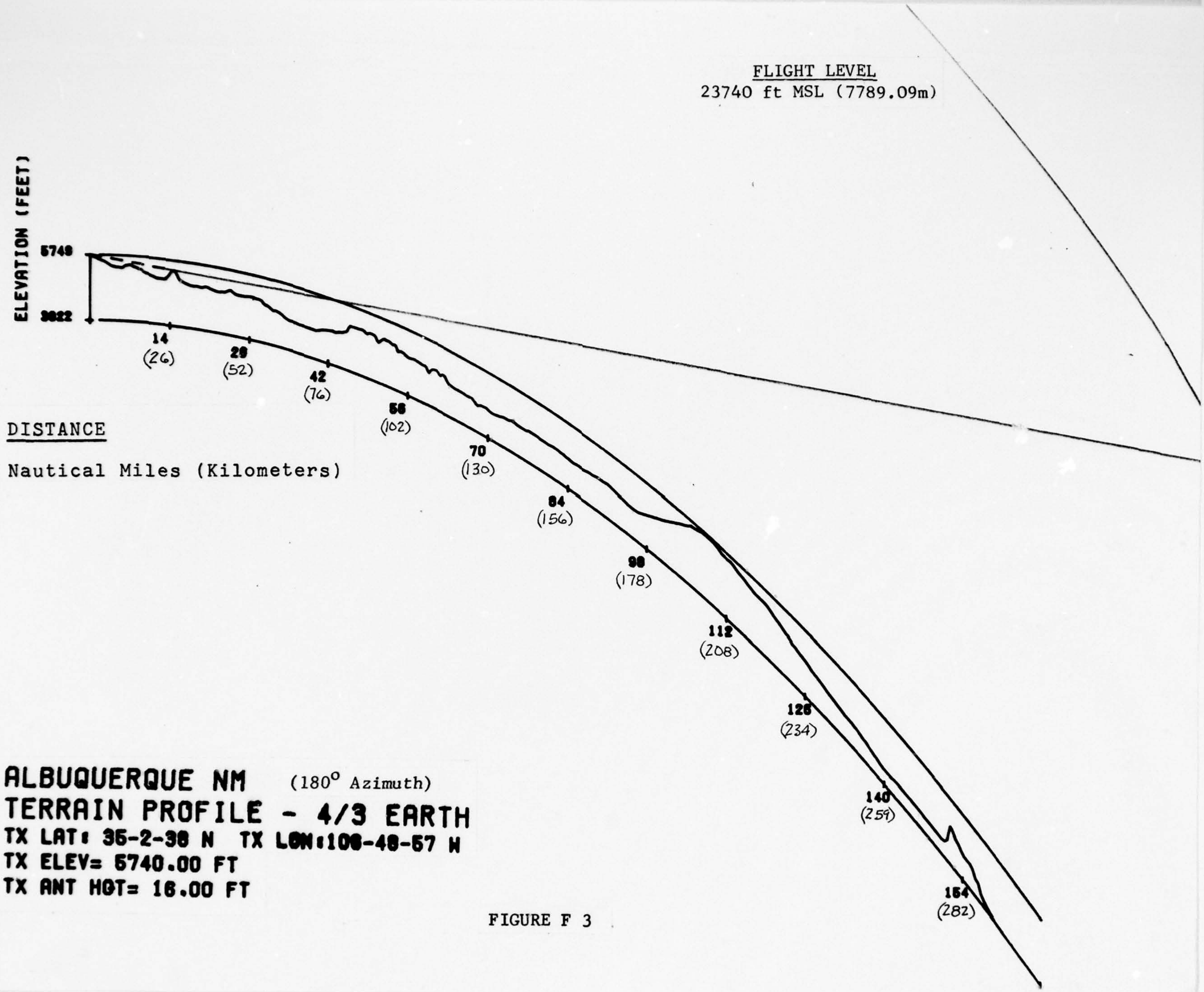
FLIGHT LEVEL
23740 ft MSL (7789.09m)
ELEVATION (FEET)
5740
3822
14 (26)
28 (52)
42 (76)
56 (102)
70 (130)
84 (156)
98 (178)
112 (208)
126 (234)
140 (259)
154 (282)
DISTANCE
Nautical Miles (Kilometers)
ALBUQUERQUE NM (180° Azimuth)
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 35-2-38 N TX LON:106-48-57 W
TX ELEV= 5740.00 FT
TX ANT HGT= 16.00 FT

FIGURE F 3

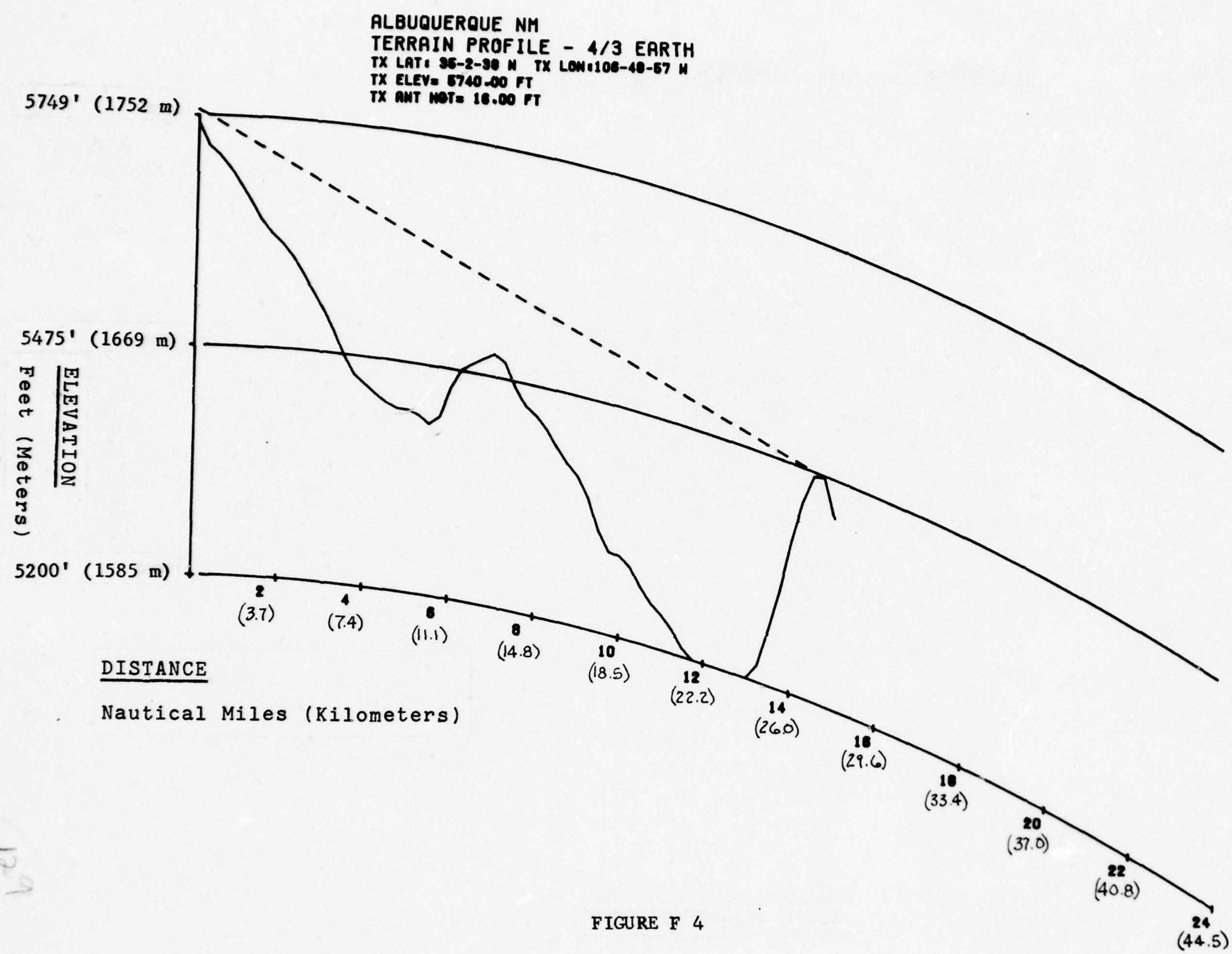

FIGURE F 4

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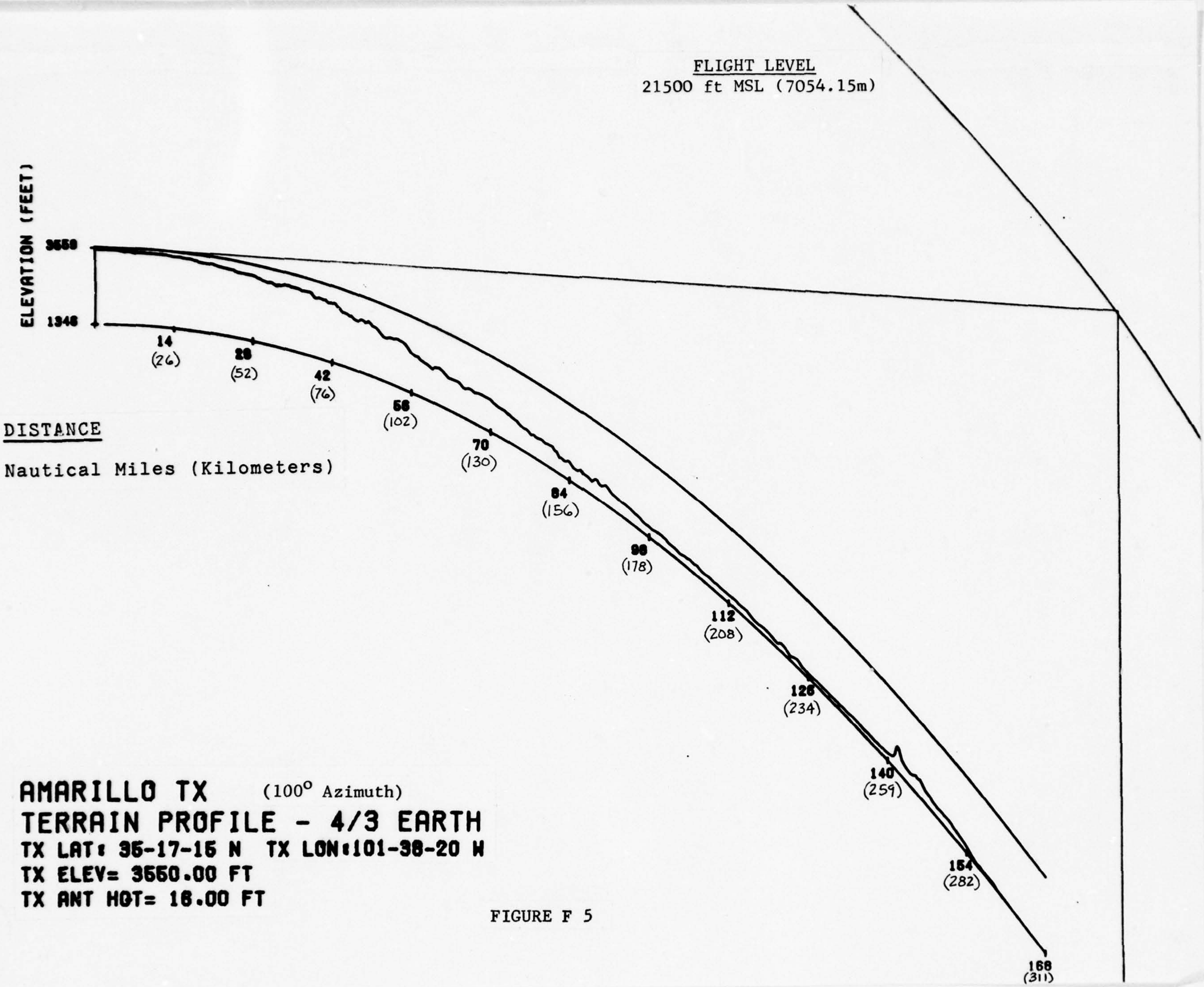

FIGURE F 5

130
90/1

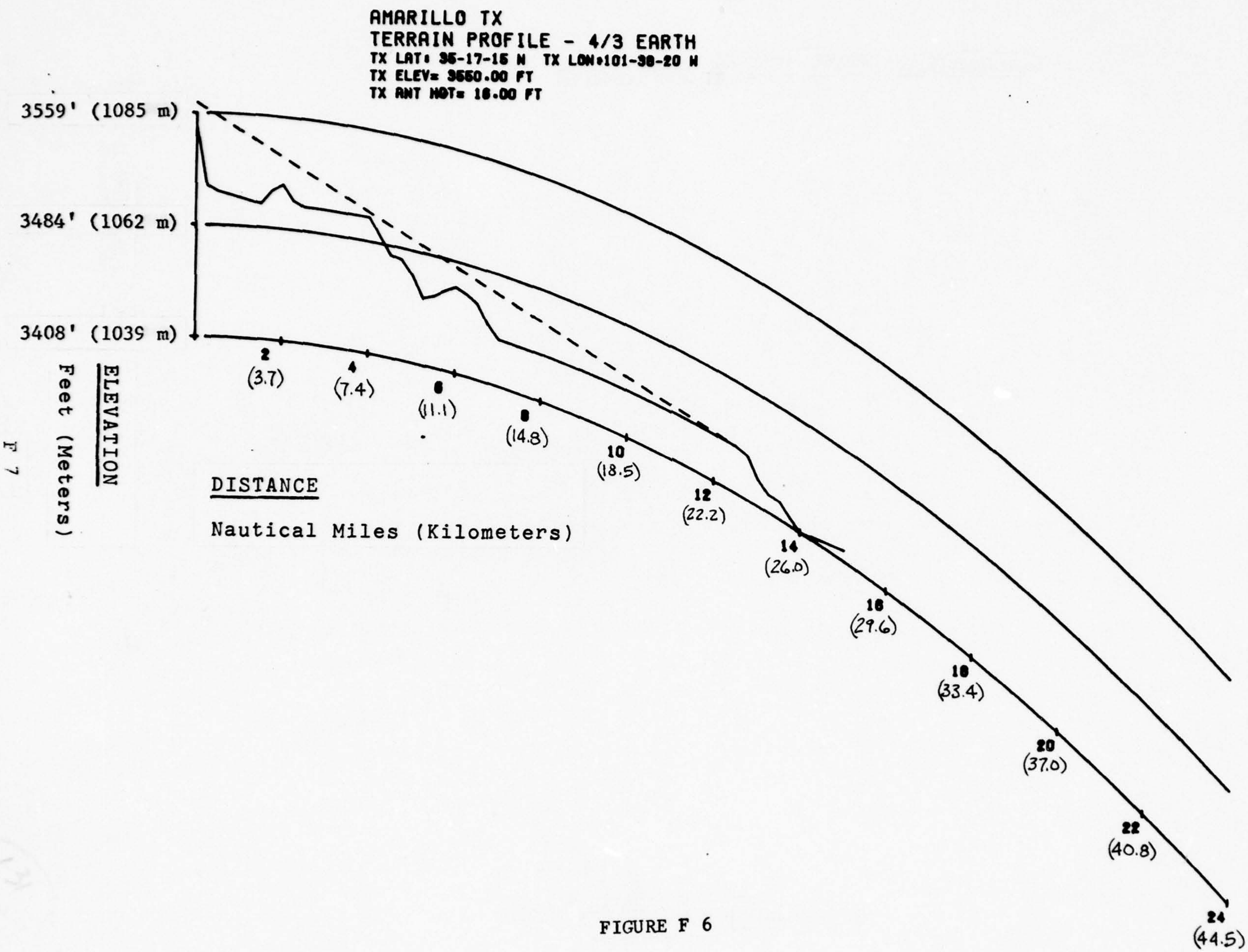
AMARILLO TX
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 35-17-15 N TX LON:101-38-20 W
TX ELEV= 3550.00 FT
TX ANT HGT= 18.00 FT
3559' (1085 m)
3484' (1062 m)
3408' (1039 m)
ELEVATION
Feet (Meters)
DISTANCE
Nautical Miles (Kilometers)
2 (3.7)
4 (7.4)
6 (11.1)
8 (14.8)
10 (18.5)
12 (22.2)
14 (26.0)
16 (29.6)
18 (33.4)
20 (37.0)
22 (40.8)
24 (44.5)

FIGURE F 6

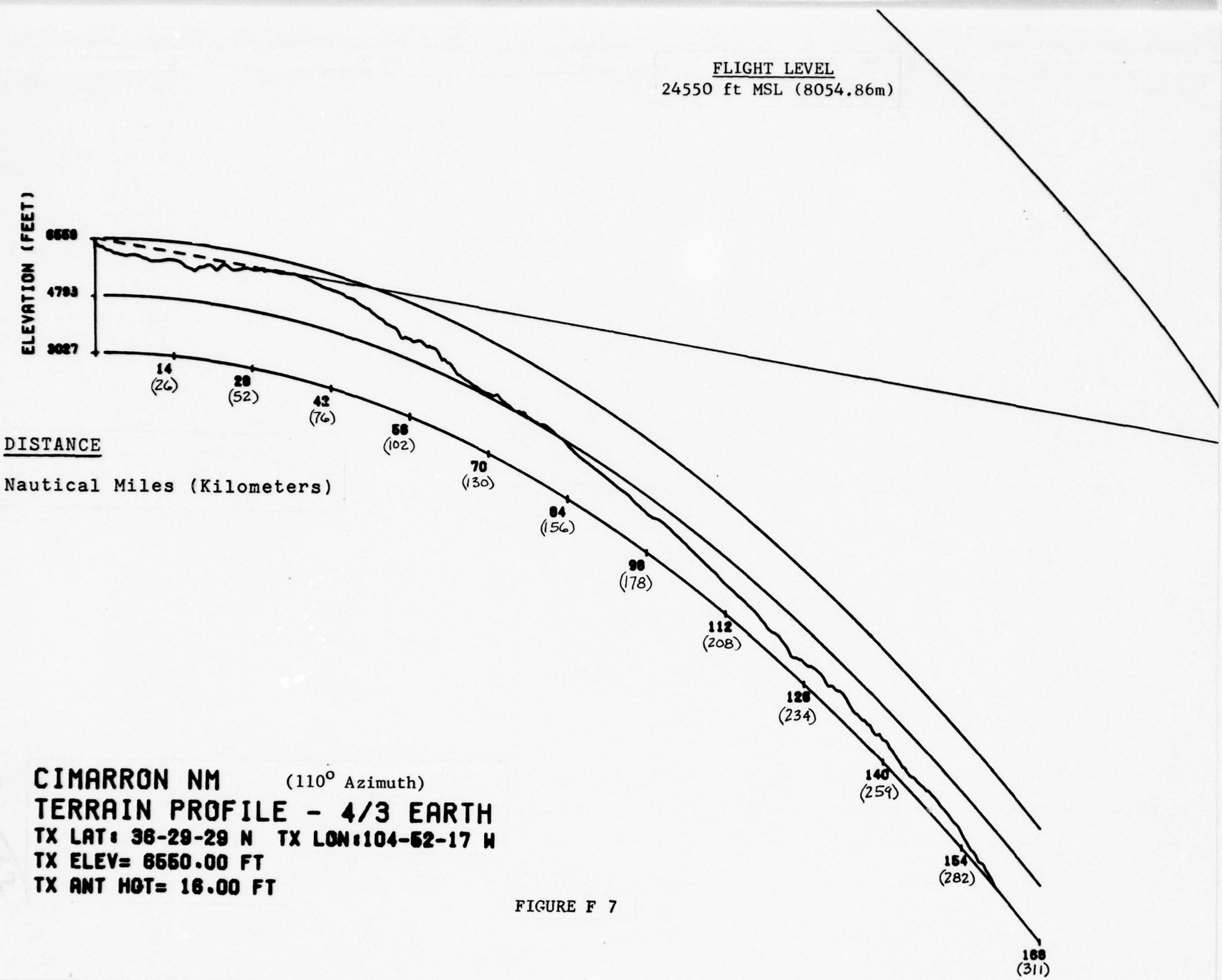
FLIGHT LEVEL
24550 ft MSL (8054.86m)
ELEVATION (FEET)
6550
4783
3027
14 (26)
28 (52)
42 (76)
56 (102)
70 (130)
84 (156)
98 (178)
112 (208)
126 (234)
140 (259)
154 (282)
168 (311)
DISTANCE
Nautical Miles (Kilometers)
CIMARRON NM (110° Azimuth)
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 36-29-29 N TX LON:104-52-17 W
TX ELEV= 6550.00 FT
TX ANT HGT= 16.00 FT

FIGURE F 7

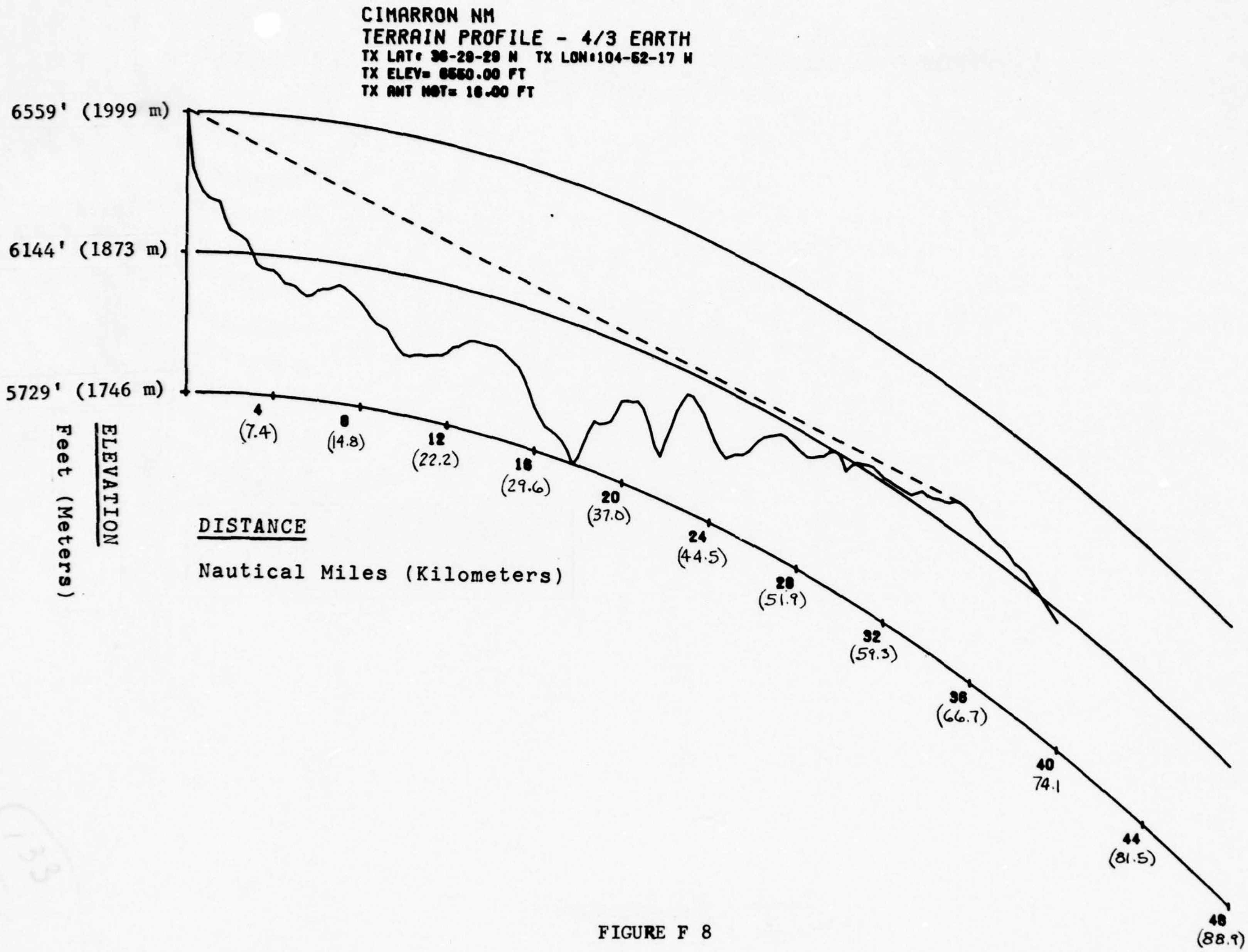

FIGURE F 8

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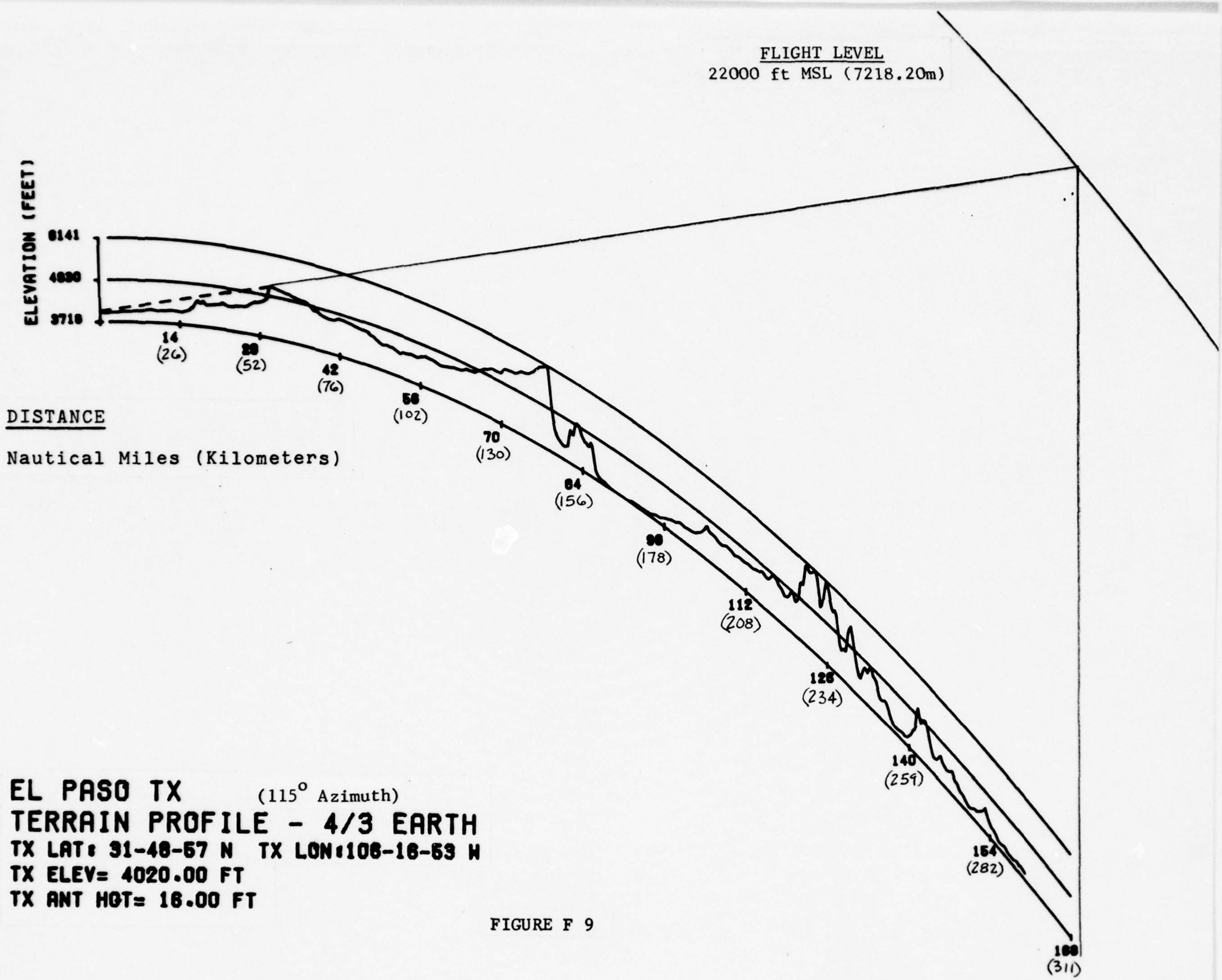

FLIGHT LEVEL
22000 ft MSL (7218.20m)
ELEVATION (FEET)
DISTANCE
Nautical Miles (Kilometers)
14 (26)
28 (52)
42 (76)
56 (102)
70 (130)
84 (156)
98 (178)
112 (208)
126 (234)
140 (259)
154 (282)
168 (311)
EL PASO TX (115° Azimuth)
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 31-48-57 N TX LON:106-16-53 W
TX ELEV= 4020.00 FT
TX ANT HGT= 16.00 FT

FIGURE F 9

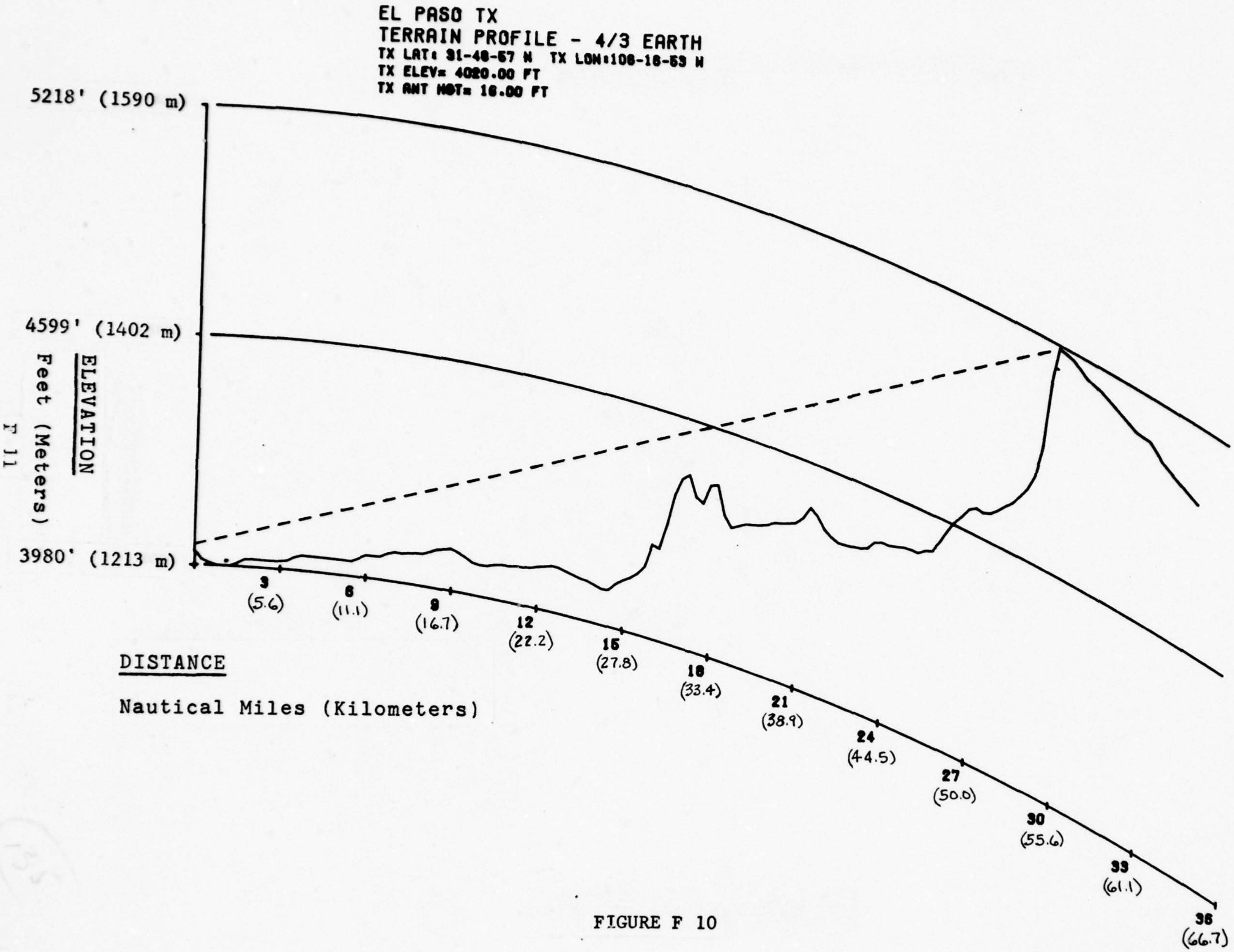
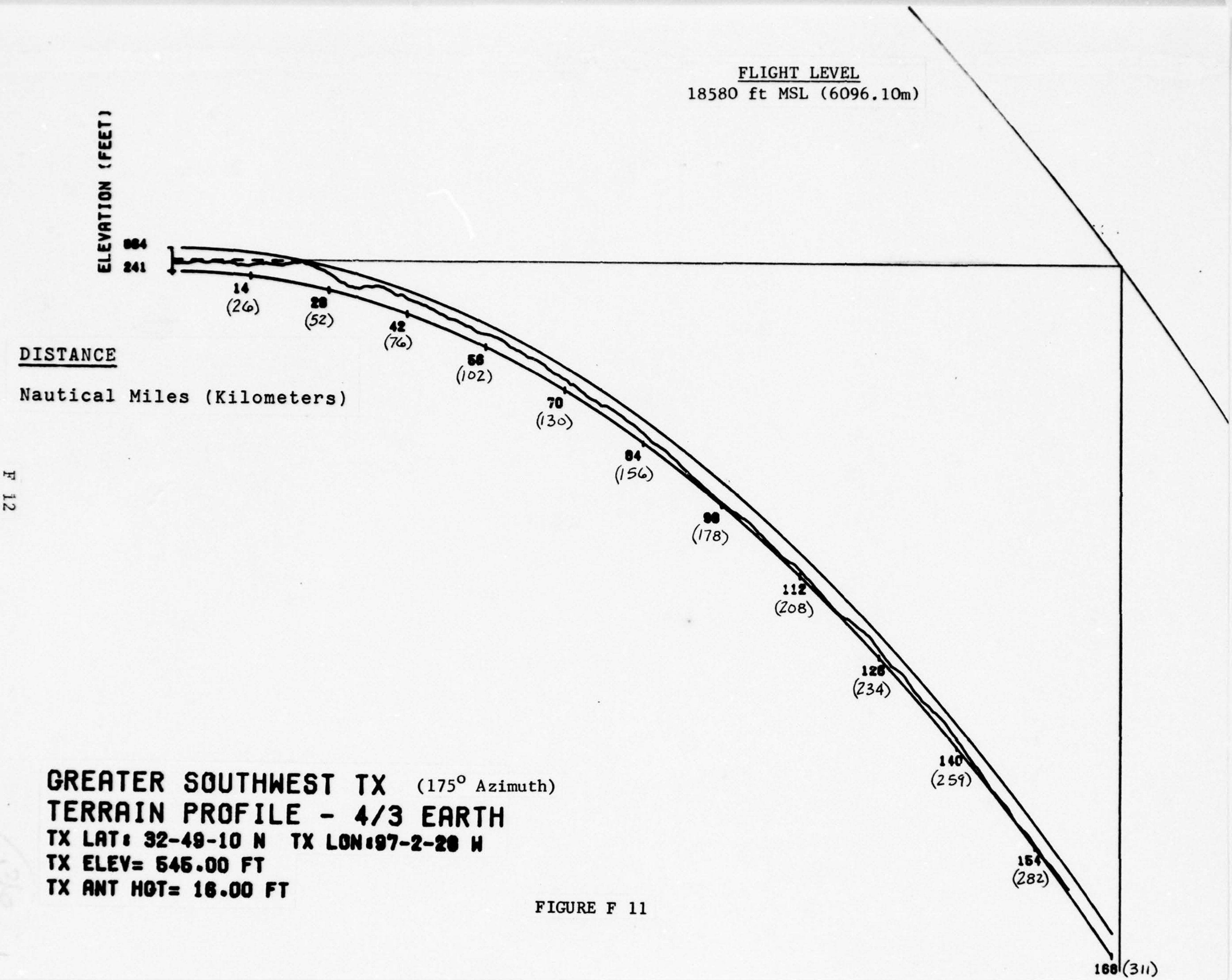

EL PASO TX
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 31-48-57 N TX LON:106-16-53 W
TX ELEV= 4020.00 FT
TX ANT HGT= 16.00 FT
5218' (1590 m)
4599' (1402 m)
3980' (1213 m)
ELEVATION
Feet (Meters)
DISTANCE
Nautical Miles (Kilometers)
3 (5.6)
6 (11.1)
9 (16.7)
12 (22.2)
15 (27.8)
18 (33.4)
21 (38.9)
24 (44.5)
27 (50.0)
30 (55.6)
33 (61.1)
36 (66.7)

FIGURE F 10



GREATER SOUTHWEST TX (175° Azimuth)
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 32-49-10 N TX LON:97-2-28 W
TX ELEV= 545.00 FT
TX ANT HGT= 16.00 FT

FIGURE F 11

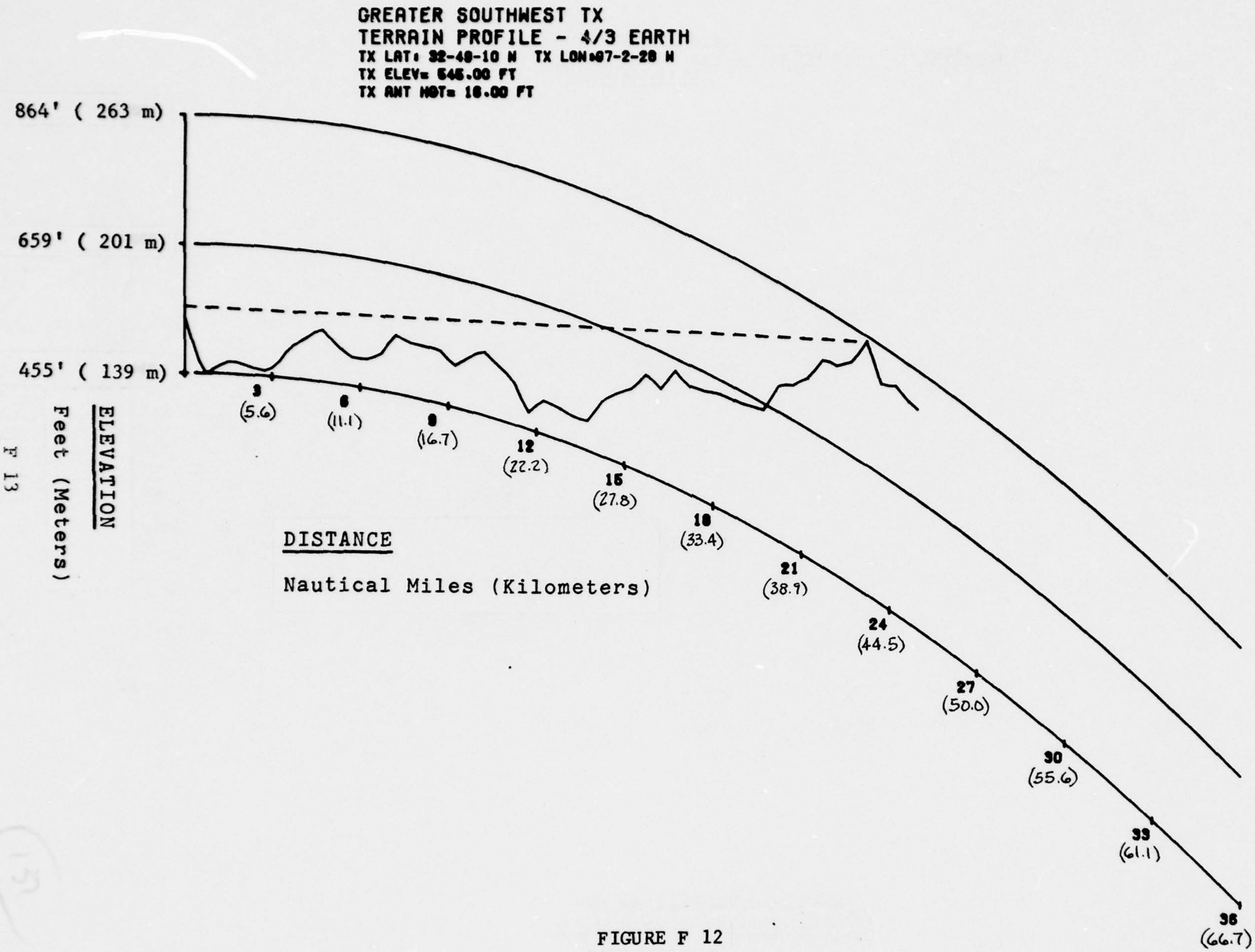
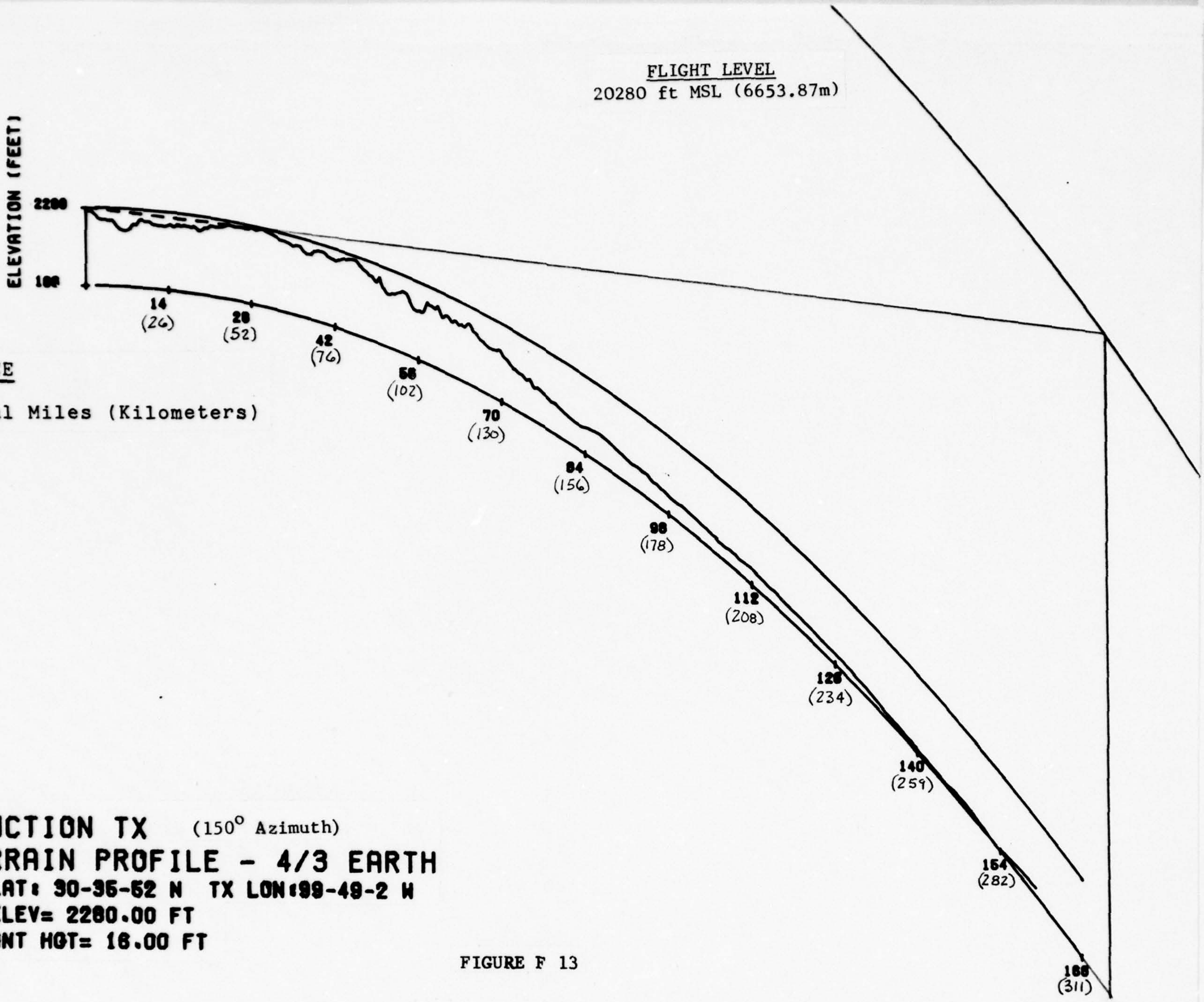

GREATER SOUTHWEST TX
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 32-48-10 N TX LON=97-2-28 W
TX ELEV= 545.00 FT
TX ANT HGT= 16.00 FT
864' (263 m)
659' (201 m)
455' (139 m)
ELEVATION
Feet (Meters)
3 (5.6)
6 (11.1)
9 (16.7)
12 (22.2)
15 (27.8)
18 (33.4)
21 (38.9)
24 (44.5)
27 (50.0)
30 (55.6)
33 (61.1)
36 (66.7)
DISTANCE
Nautical Miles (Kilometers)

FIGURE F 12



JUNCTION TX (150° Azimuth)
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 30-35-52 N TX LON:99-49-2 W
TX ELEV= 2280.00 FT
TX ANT HGT= 16.00 FT

FIGURE F 13

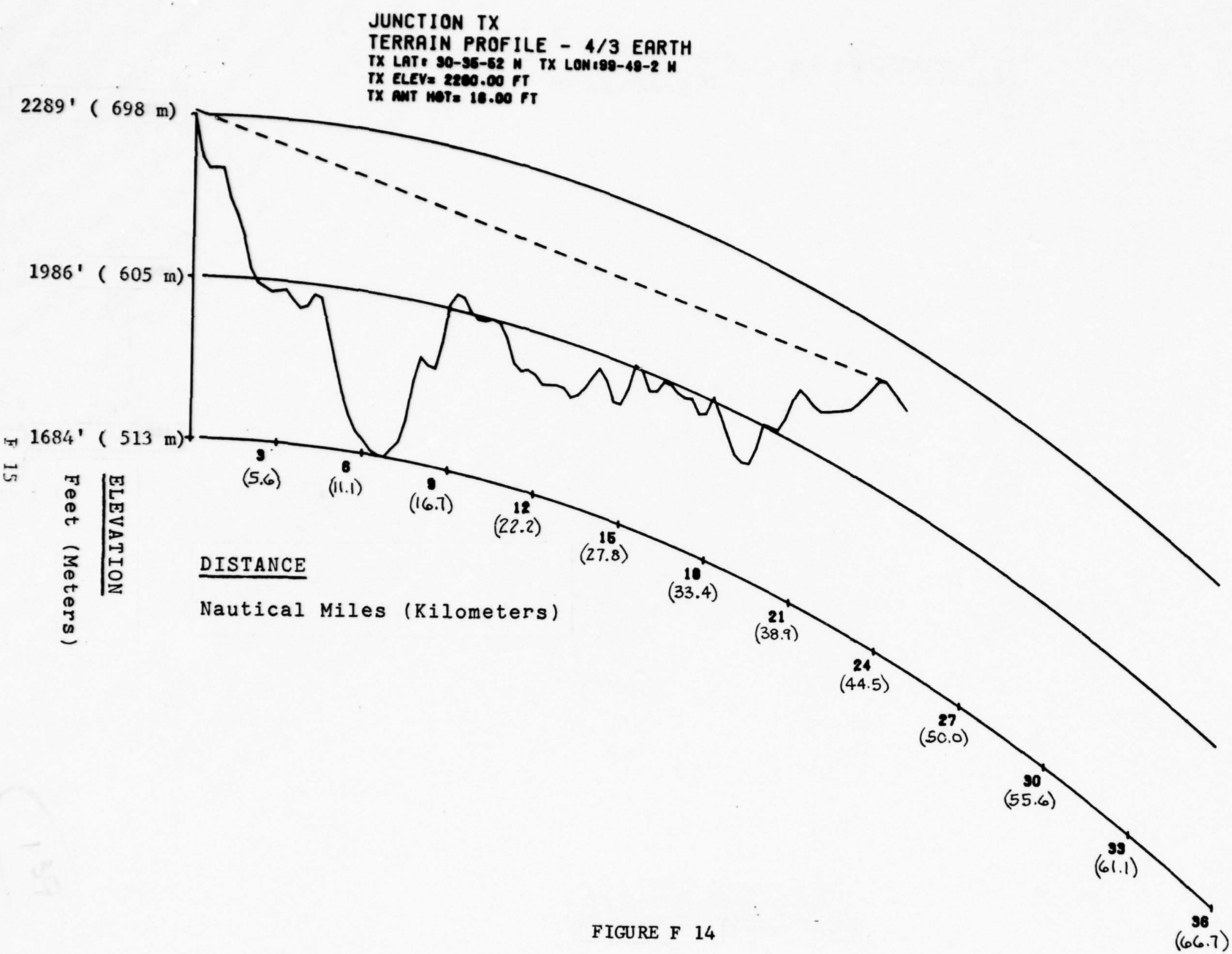
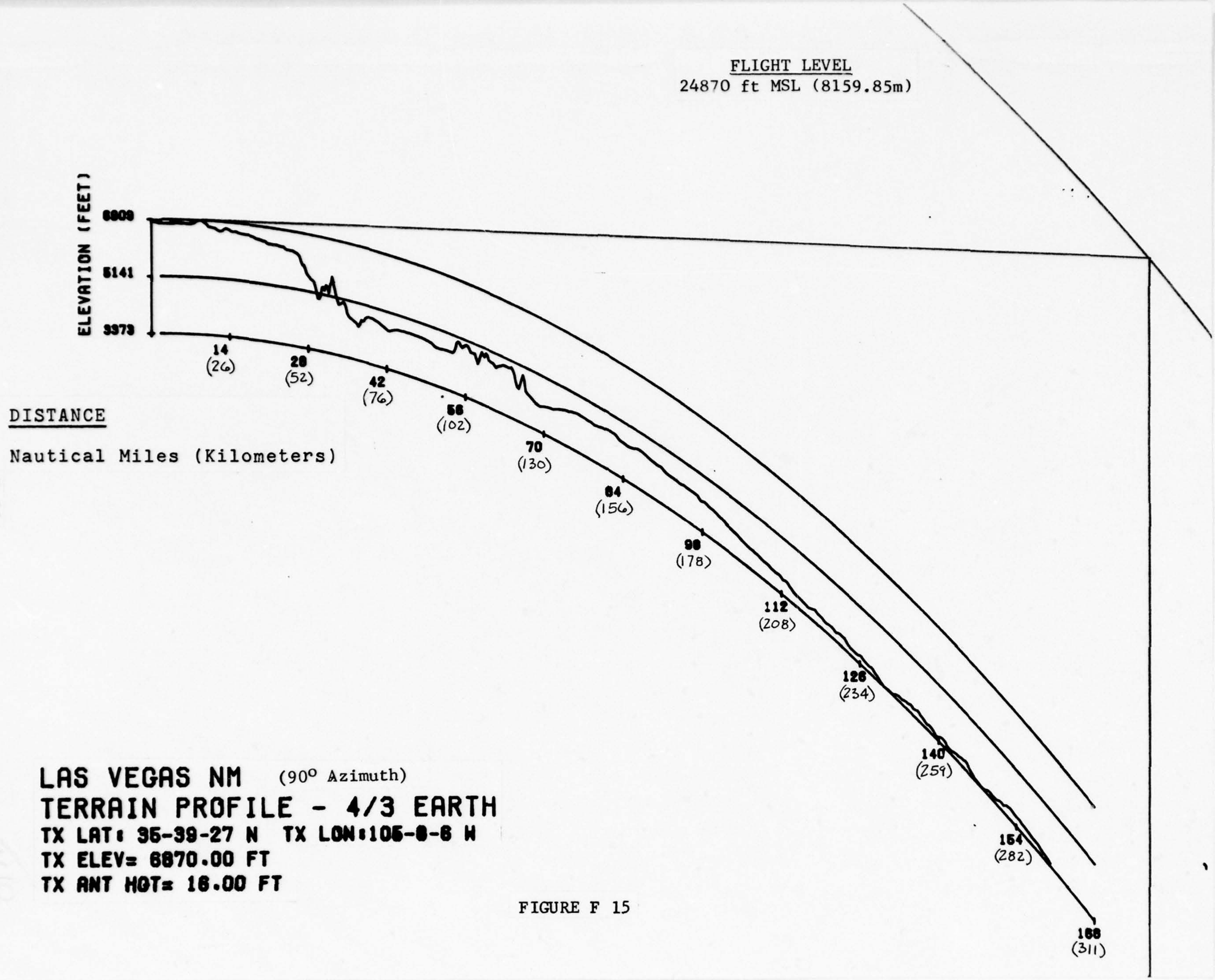

JUNCTION TX
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 30-35-52 N TX LON:99-49-2 W
TX ELEV= 2280.00 FT
TX ANT HGT= 18.00 FT
2289' (698 m)
1986' (605 m)
1684' (513 m)
ELEVATION
Feet (Meters)
DISTANCE
Nautical Miles (Kilometers)
3 (5.6)
6 (11.1)
9 (16.7)
12 (22.2)
15 (27.8)
18 (33.4)
21 (38.9)
24 (44.5)
27 (50.0)
30 (55.6)
33 (61.1)
36 (66.7)

FIGURE F 14



LAS VEGAS NM (90° Azimuth)
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 35-39-27 N TX LON:105-8-6 W
TX ELEV= 6870.00 FT
TX ANT HGT= 16.00 FT

FIGURE F 15

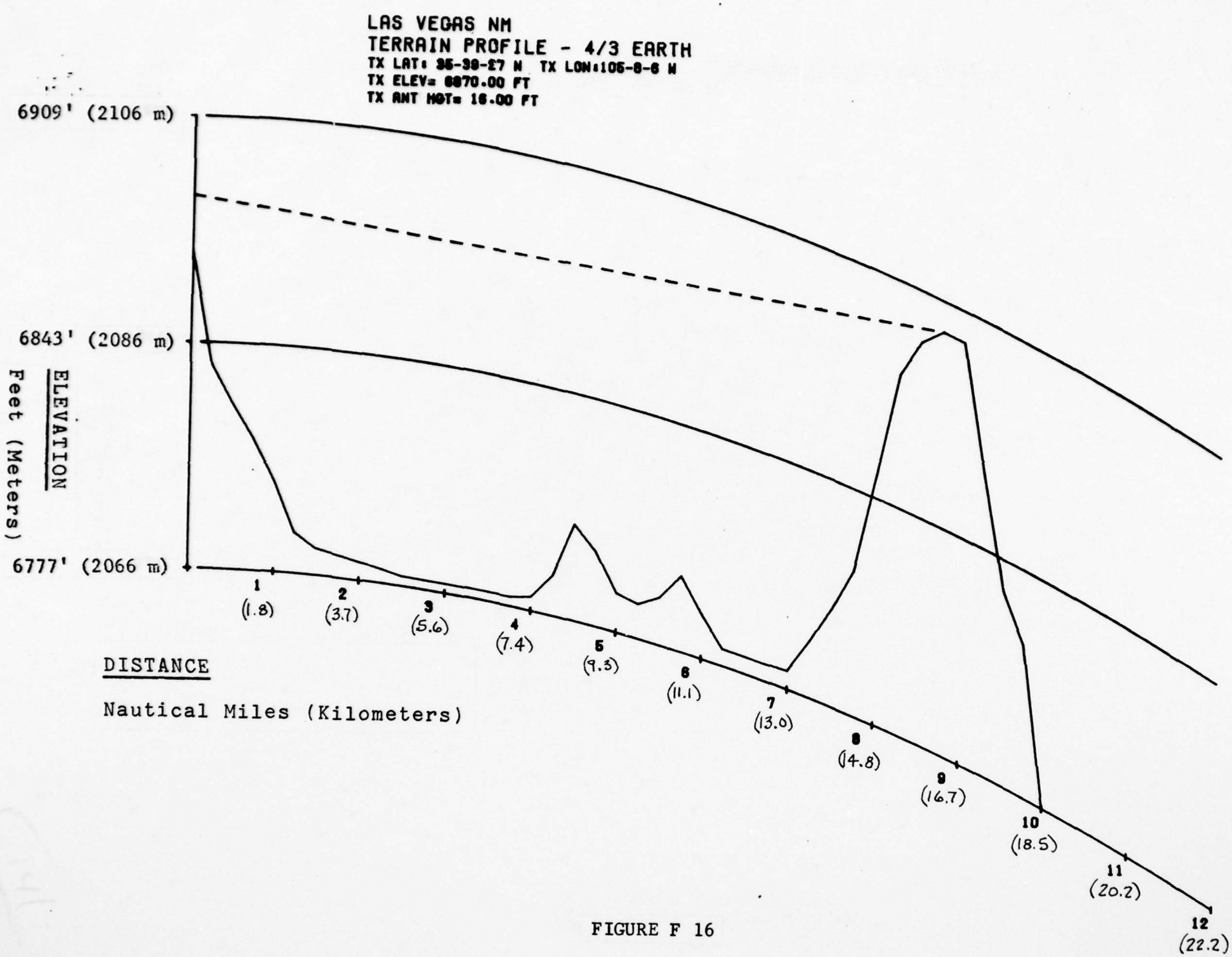

LAS VEGAS NM
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 35-39-27 N TX LON:105-8-6 W
TX ELEV= 6870.00 FT
TX ANT HGT= 16.00 FT
6909' (2106 m)
6843' (2086 m)
6777' (2066 m)
ELEVATION
Feet (Meters)
DISTANCE
Nautical Miles (Kilometers)
1 (1.8)
2 (3.7)
3 (5.6)
4 (7.4)
5 (9.3)
6 (11.1)
7 (13.0)
8 (14.8)
9 (16.7)
10 (18.5)
11 (20.2)
12 (22.2)

FIGURE F 16

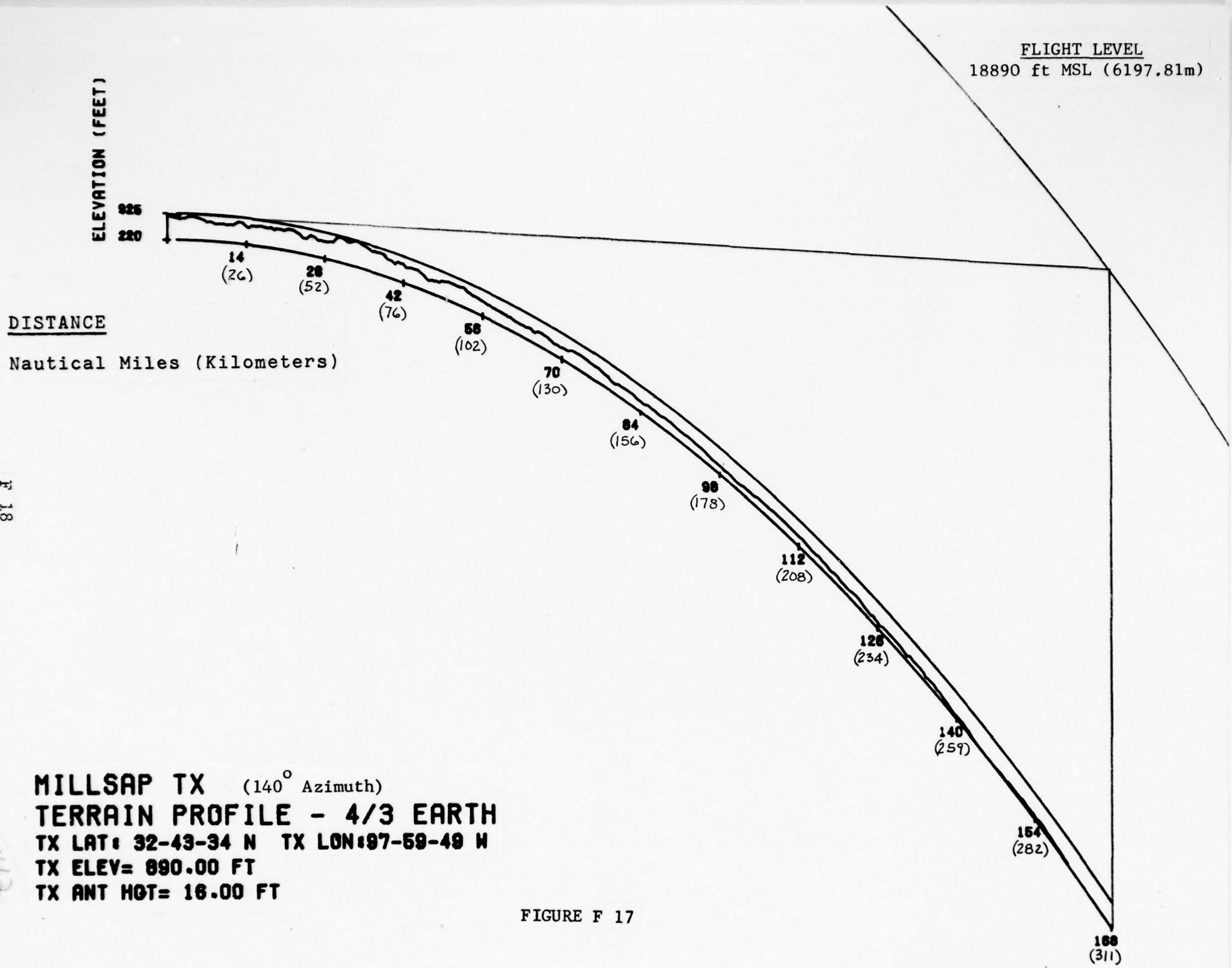


FIGURE F 17

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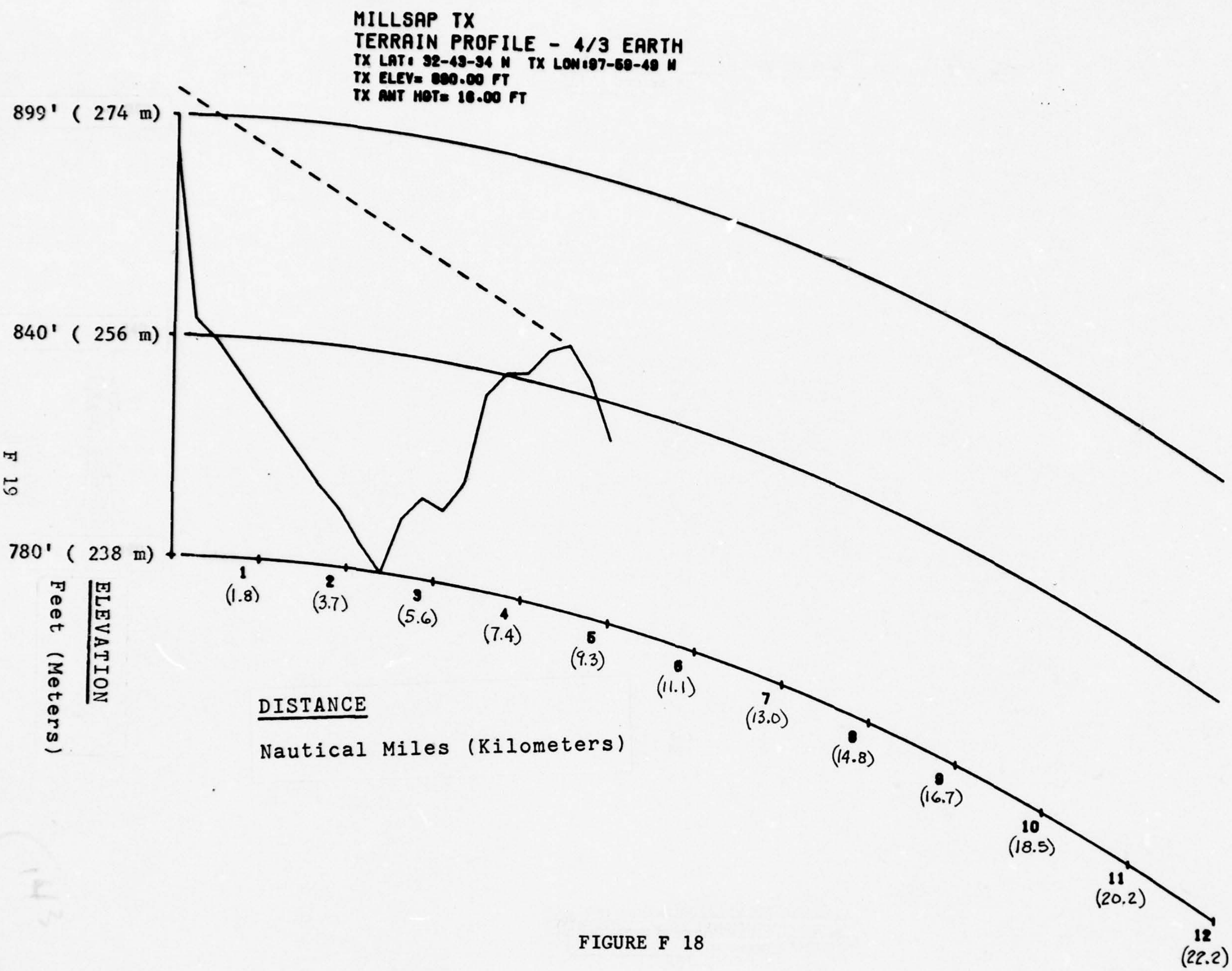
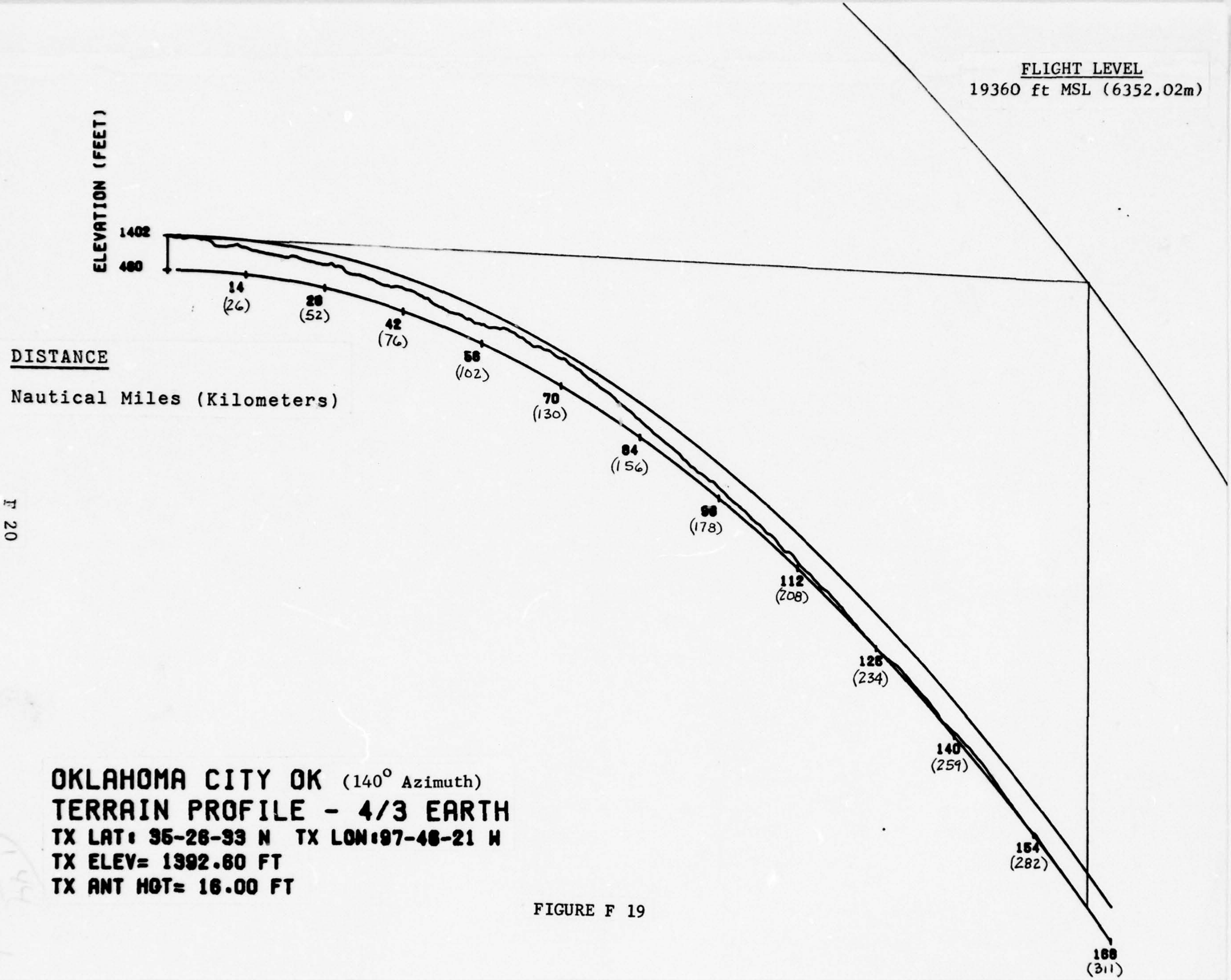

MILLSAP TX
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 32-43-34 N TX LON:97-59-49 W
TX ELEV= 880.00 FT
TX ANT HGT= 16.00 FT
899' (274 m)
840' (256 m)
780' (238 m)
ELEVATION
Feet (Meters)
DISTANCE
Nautical Miles (Kilometers)
1 (1.8)
2 (3.7)
3 (5.6)
4 (7.4)
5 (9.3)
6 (11.1)
7 (13.0)
8 (14.8)
9 (16.7)
10 (18.5)
11 (20.2)
12 (22.2)

FIGURE F 18



OKLAHOMA CITY OK (140° Azimuth)
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 35-26-33 N TX LON:97-48-21 W
TX ELEV= 1392.60 FT
TX ANT HGT= 16.00 FT

FIGURE F 19

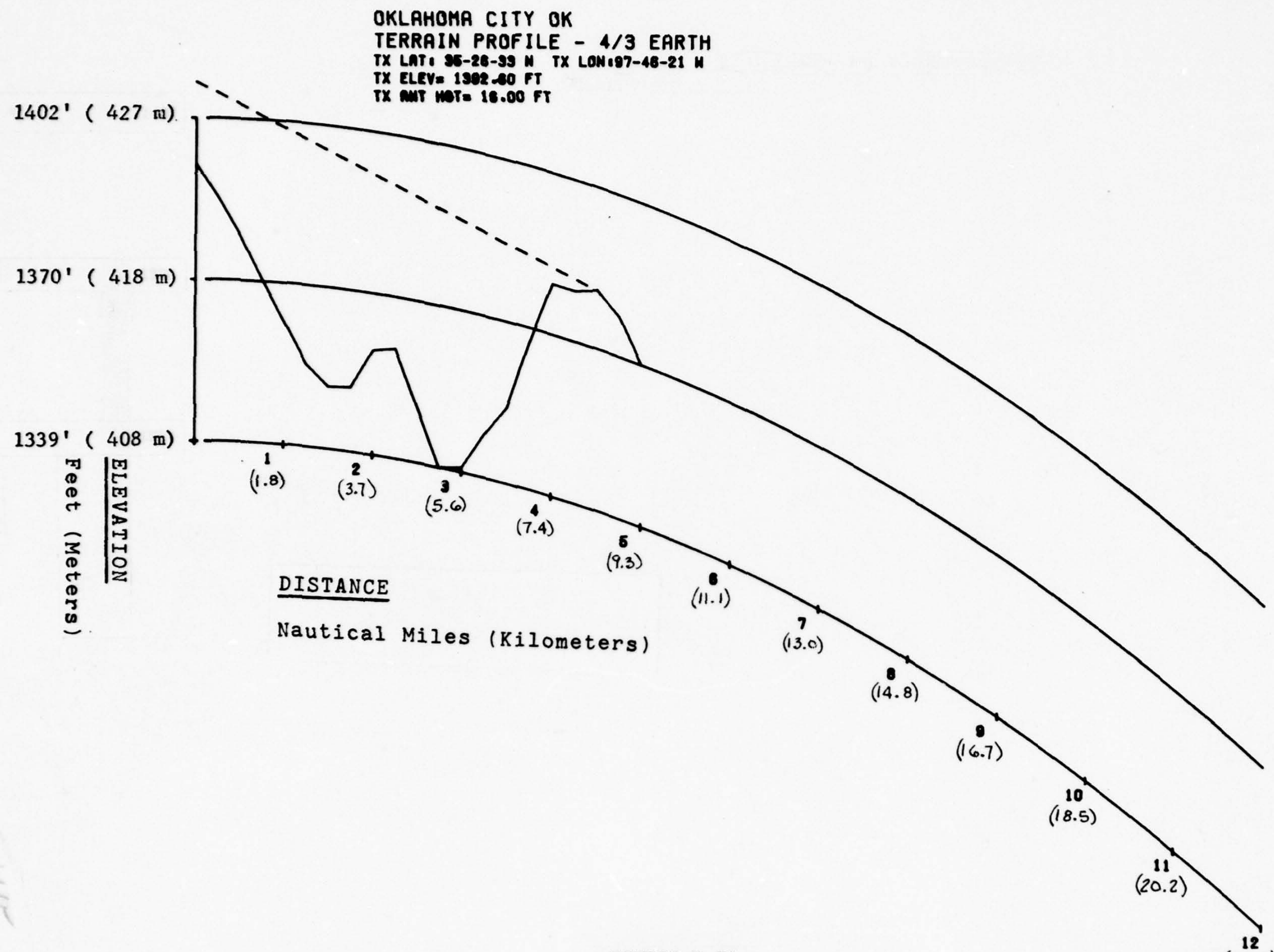
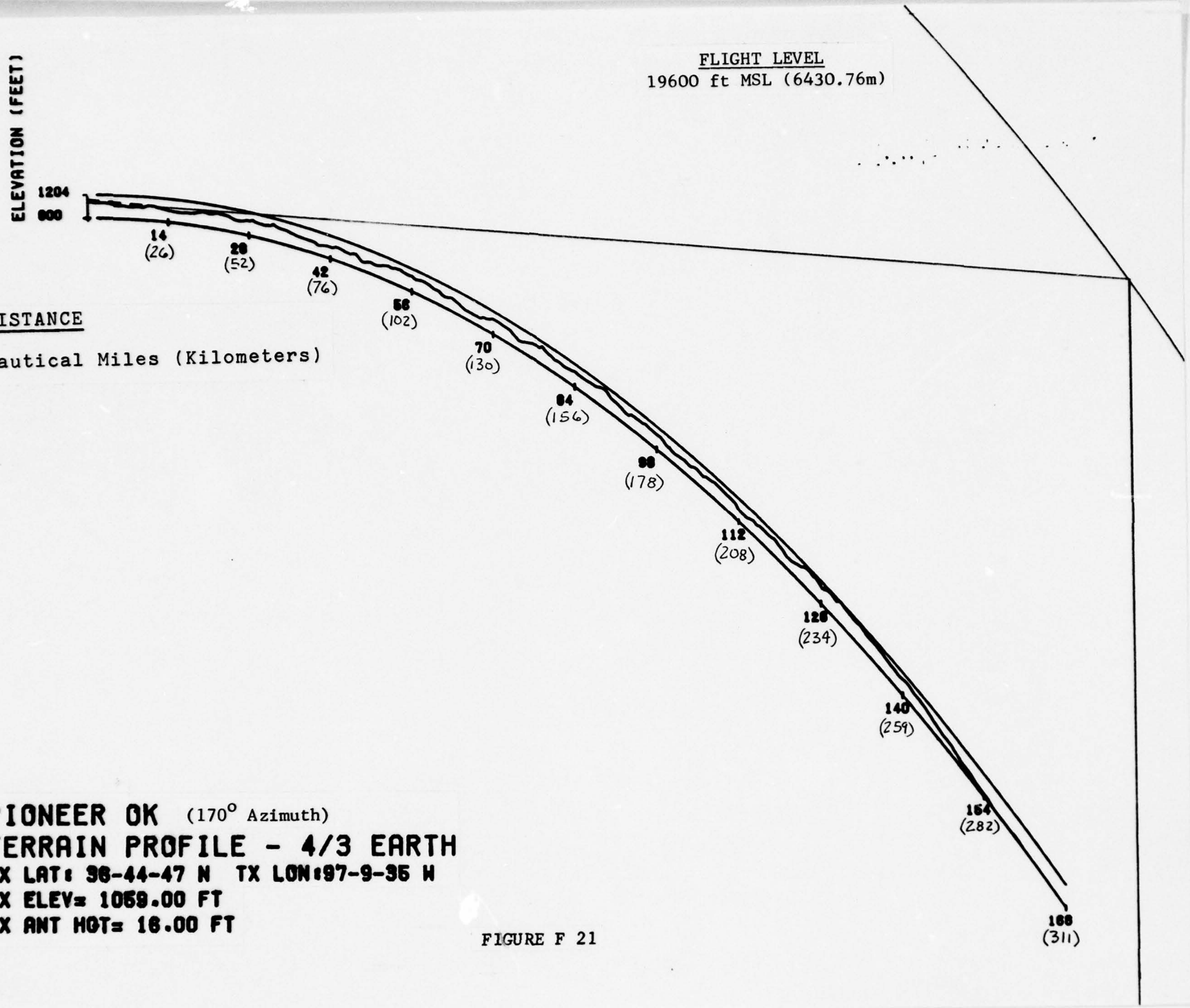


FIGURE F 20

145



PIONEER OK (170° Azimuth)
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 36-44-47 N TX LON:97-9-35 W
TX ELEV= 1059.00 FT
TX ANT HGT= 16.00 FT

FIGURE F 21

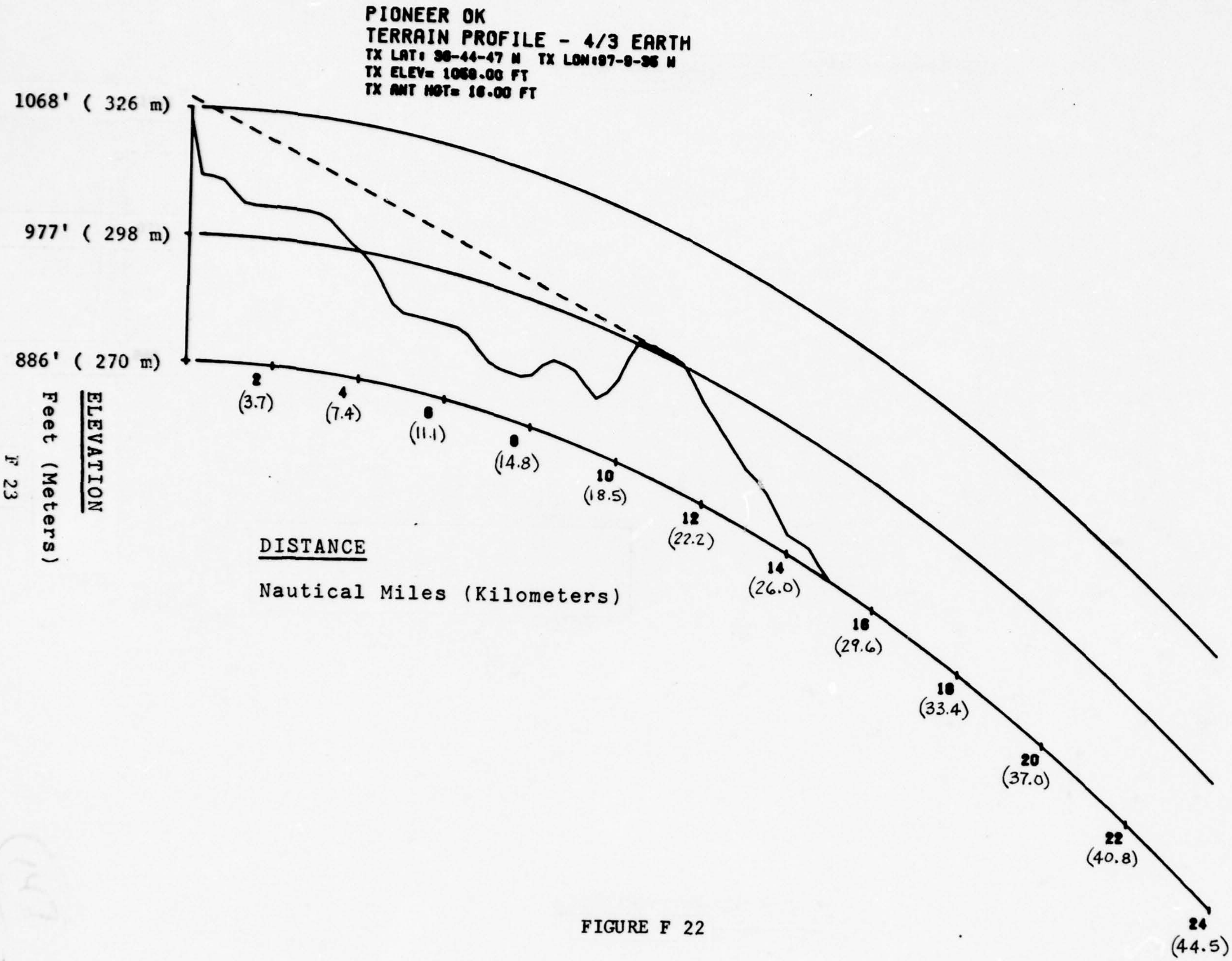
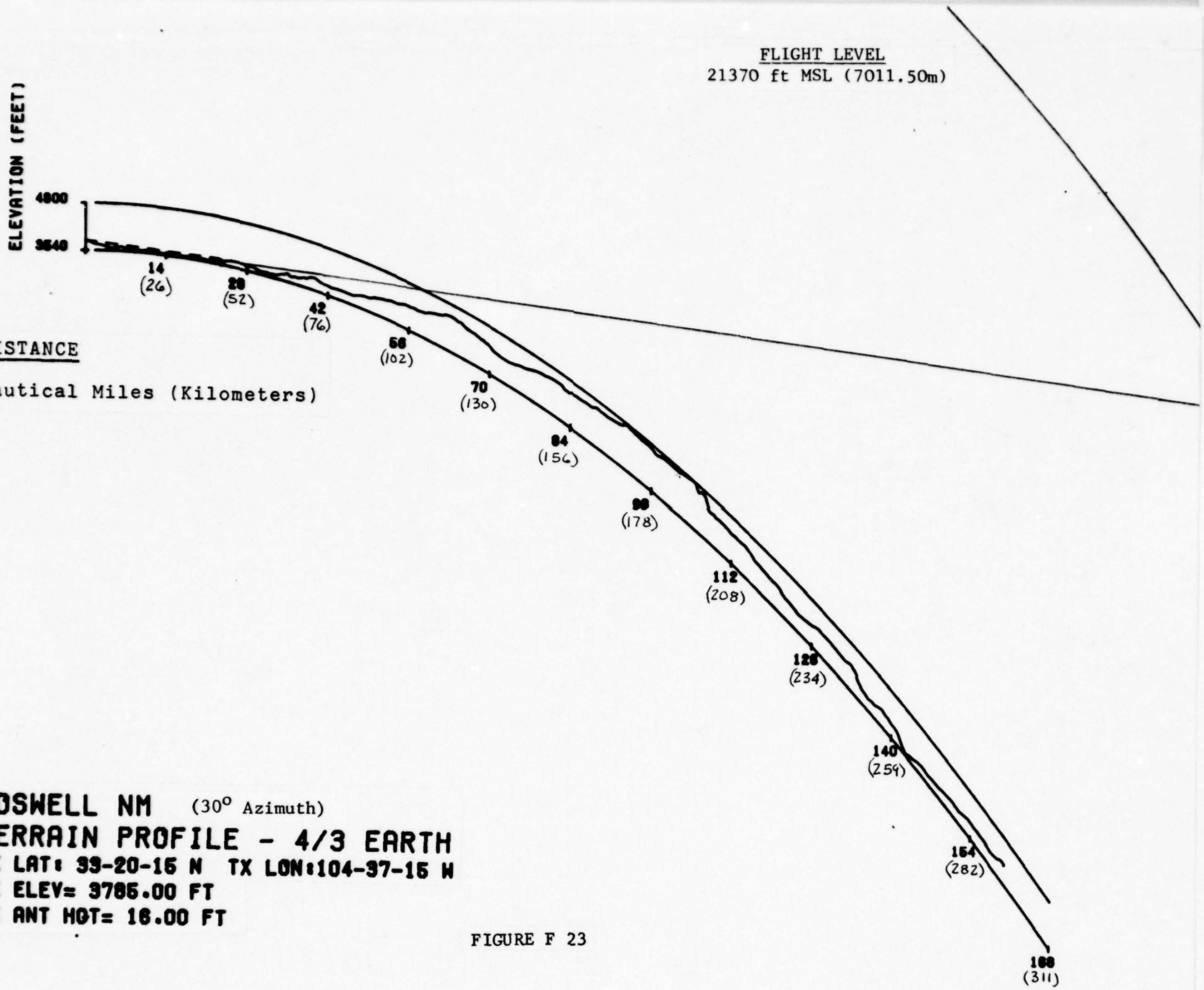

PIONEER OK
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 36-44-47 N TX LON:97-8-36 W
TX ELEV= 1052.00 FT
TX ANT HGT= 16.00 FT
1068' (326 m)
977' (298 m)
886' (270 m)
ELEVATION
Feet (Meters)
2 (3.7)
4 (7.4)
6 (11.1)
8 (14.8)
10 (18.5)
12 (22.2)
14 (26.0)
16 (29.6)
18 (33.4)
20 (37.0)
22 (40.8)
24 (44.5)
DISTANCE
Nautical Miles (Kilometers)

FIGURE F 22



ROSWELL NM (30° Azimuth)
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 33-20-15 N TX LON:104-37-15 W
TX ELEV= 3785.00 FT
TX ANT HGT= 16.00 FT

FIGURE F 23

148

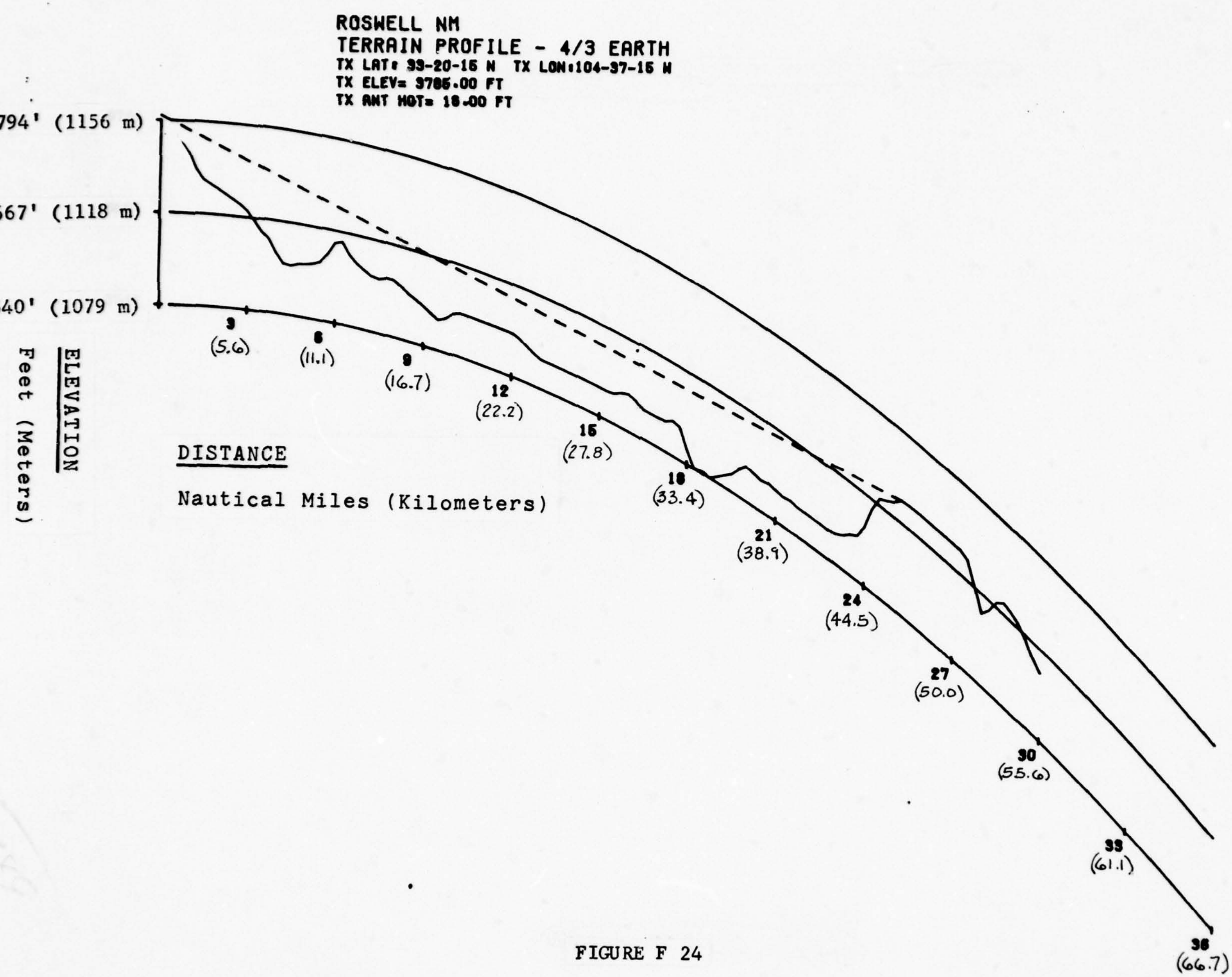

ROSWELL NM
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 33-20-15 N TX LON:104-37-15 W
TX ELEV= 3785.00 FT
TX ANT HGT= 18.00 FT
3794' (1156 m)
3667' (1118 m)
3540' (1079 m)
ELEVATION
Feet (Meters)
DISTANCE
Nautical Miles (Kilometers)
3 (5.6)
6 (11.1)
9 (16.7)
12 (22.2)
15 (27.8)
18 (33.4)
21 (38.9)
24 (44.5)
27 (50.0)
30 (55.6)
33 (61.1)
36 (66.7)

FIGURE F 24

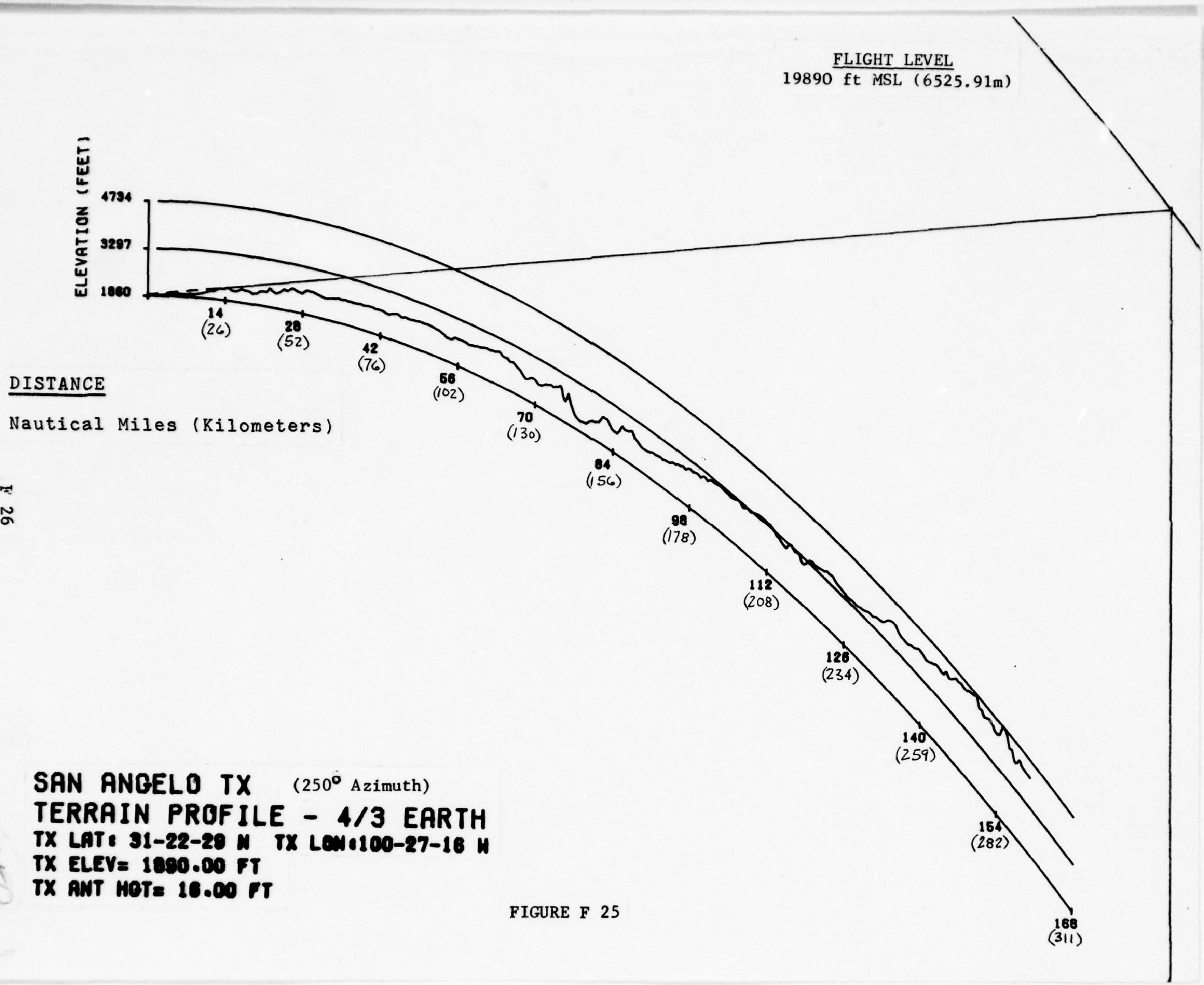


FIGURE F 25

150

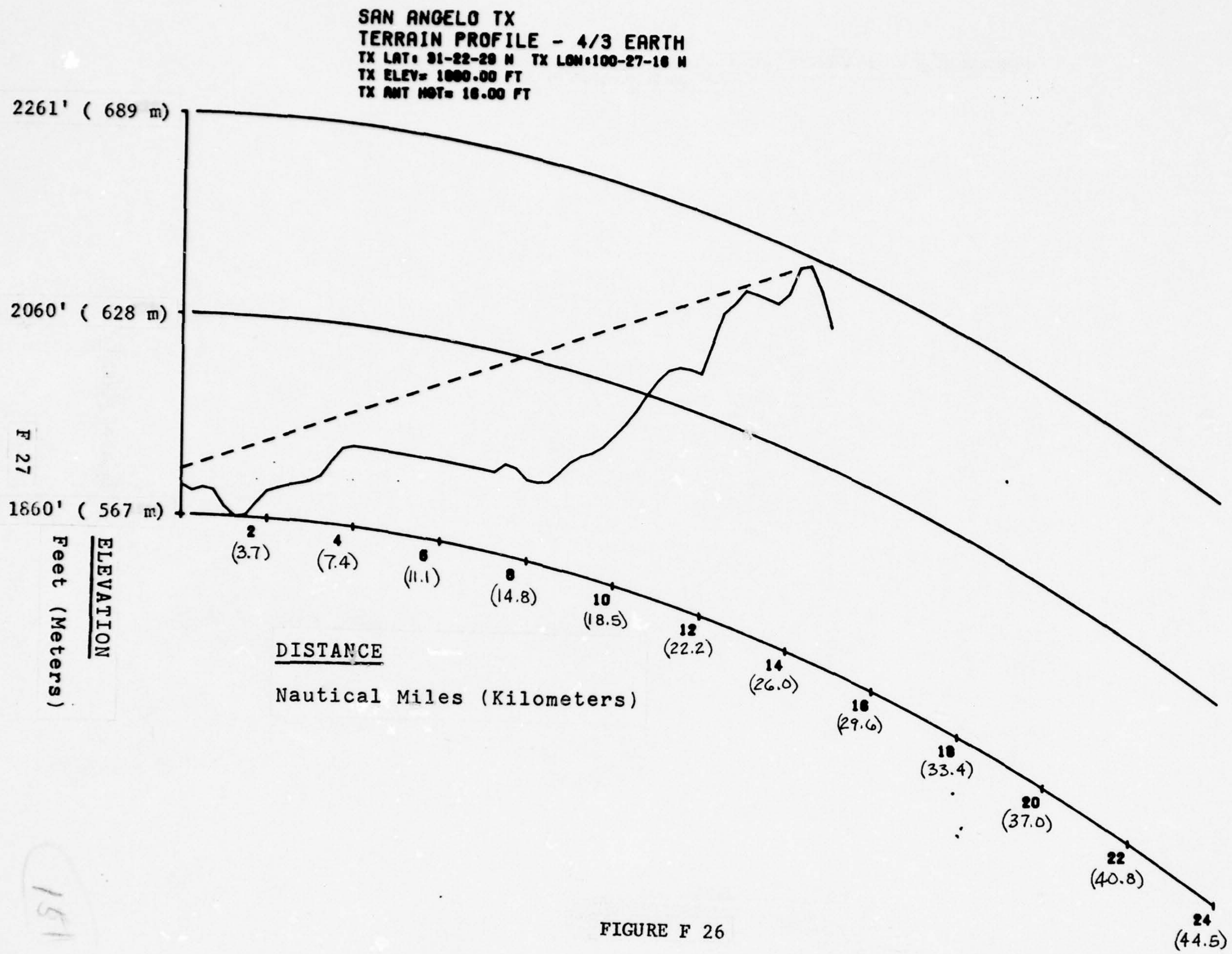


FIGURE F 26

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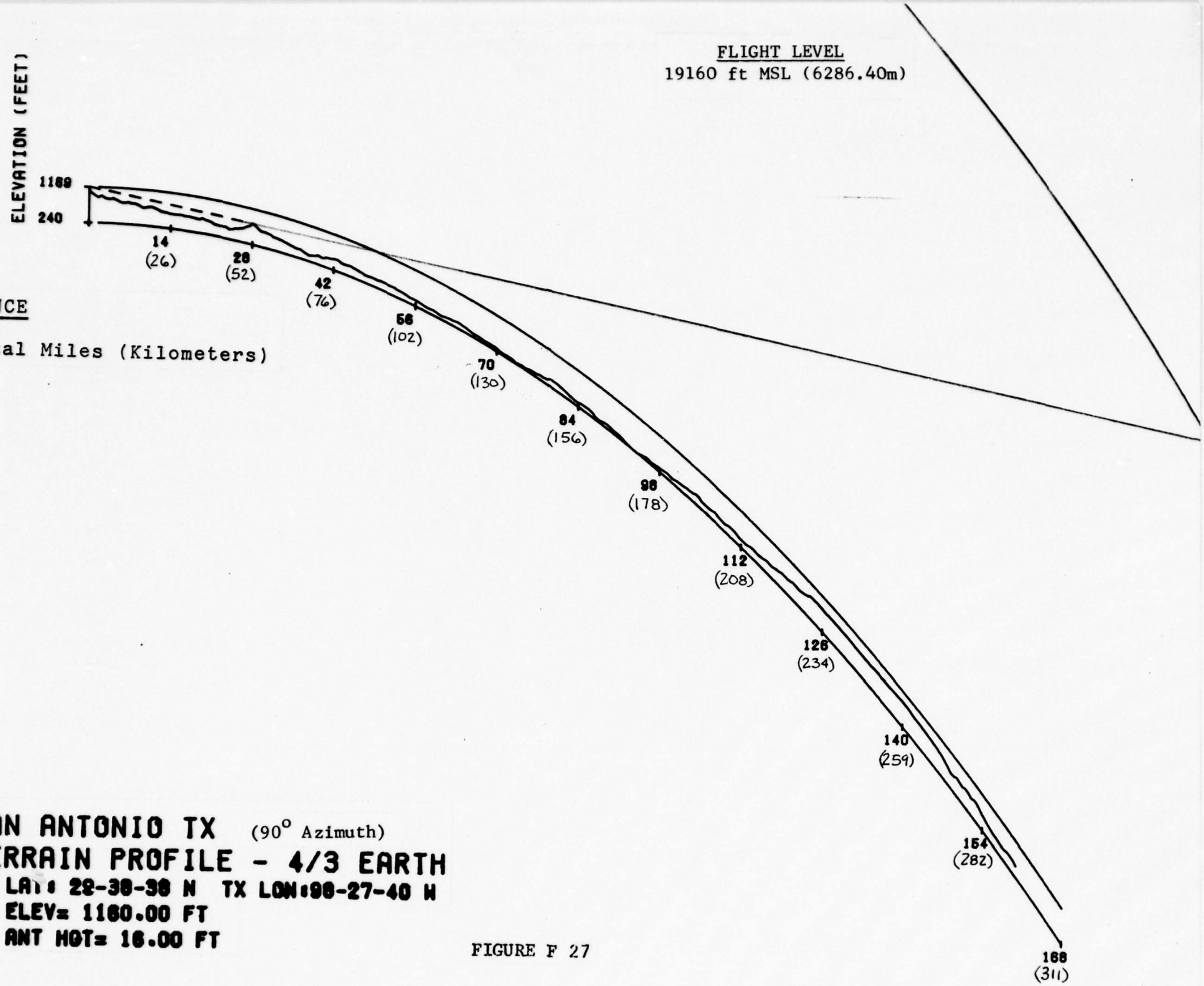


DISTANCE

Nautical Miles (Kilometers)

SAN ANTONIO TX (90° Azimuth)
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 29-30-30 N TX LON: 98-27-40 W
TX ELEV= 1160.00 FT
TX ANT HGT= 16.00 FT

FIGURE F 27

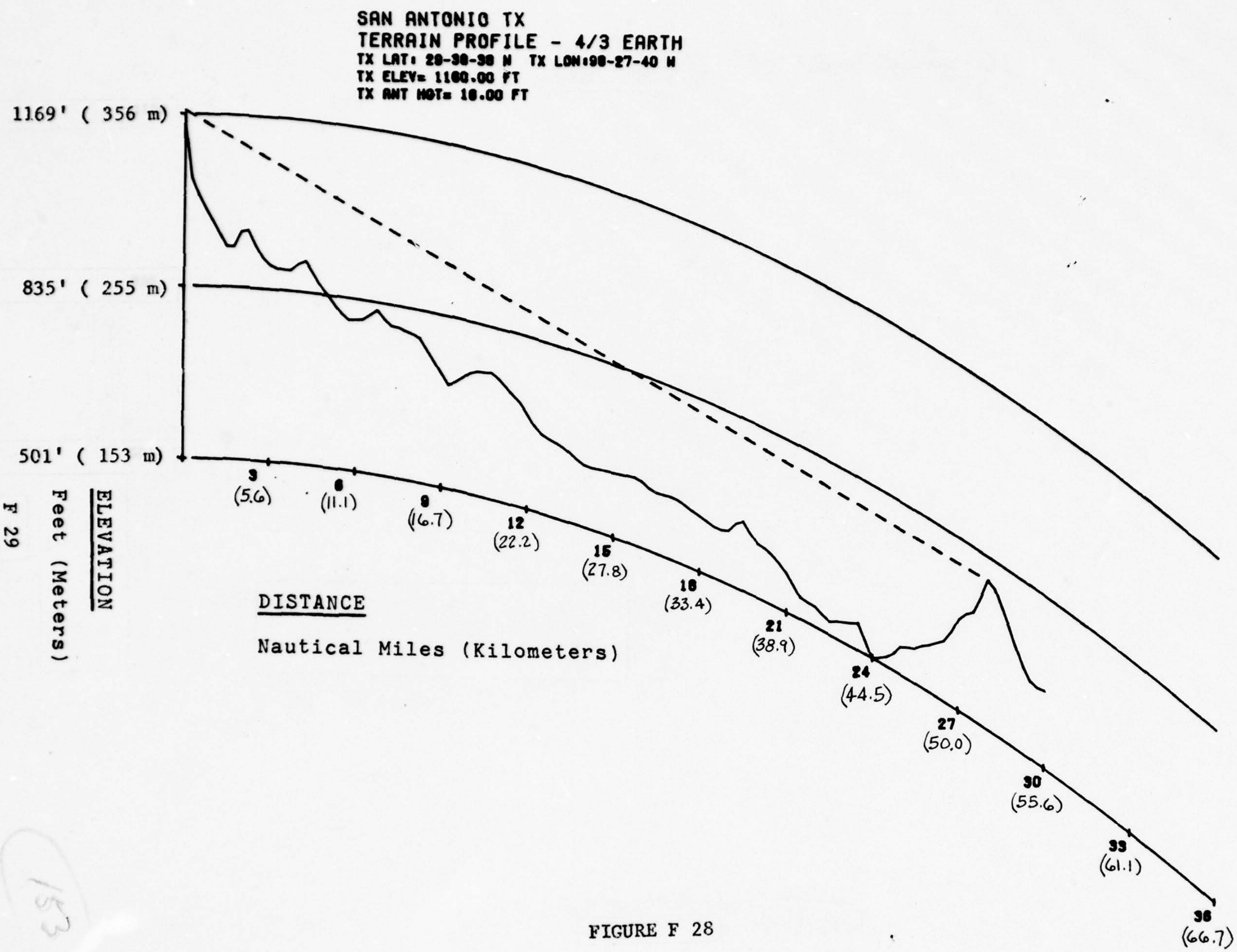
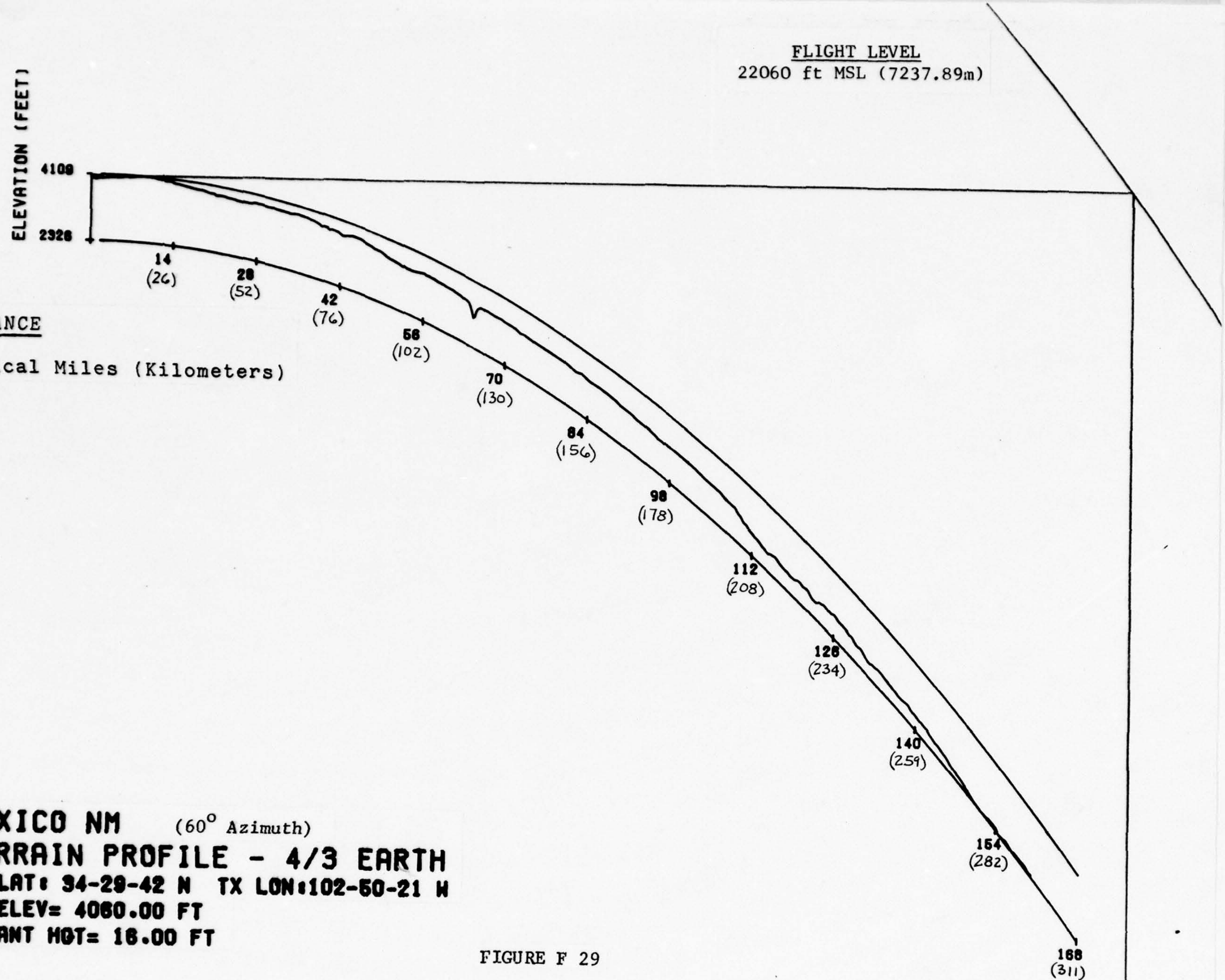

SAN ANTONIO TX
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 29-30-30 N TX LON:98-27-40 W
TX ELEV= 1160.00 FT
TX ANT HGT= 10.00 FT
1169' (356 m)
835' (255 m)
501' (153 m)
ELEVATION
Feet (Meters)
DISTANCE
Nautical Miles (Kilometers)
3 (5.6)
6 (11.1)
9 (16.7)
12 (22.2)
15 (27.8)
18 (33.4)
21 (38.9)
24 (44.5)
27 (50.0)
30 (55.6)
33 (61.1)
36 (66.7)

FIGURE F 28



TEXICO NM (60° Azimuth)

TERRAIN PROFILE - 4/3 EARTH

TX LAT: 34-29-42 N TX LON:102-50-21 W

TX ELEV= 4060.00 FT

TX ANT HGT= 16.00 FT

FIGURE F 29

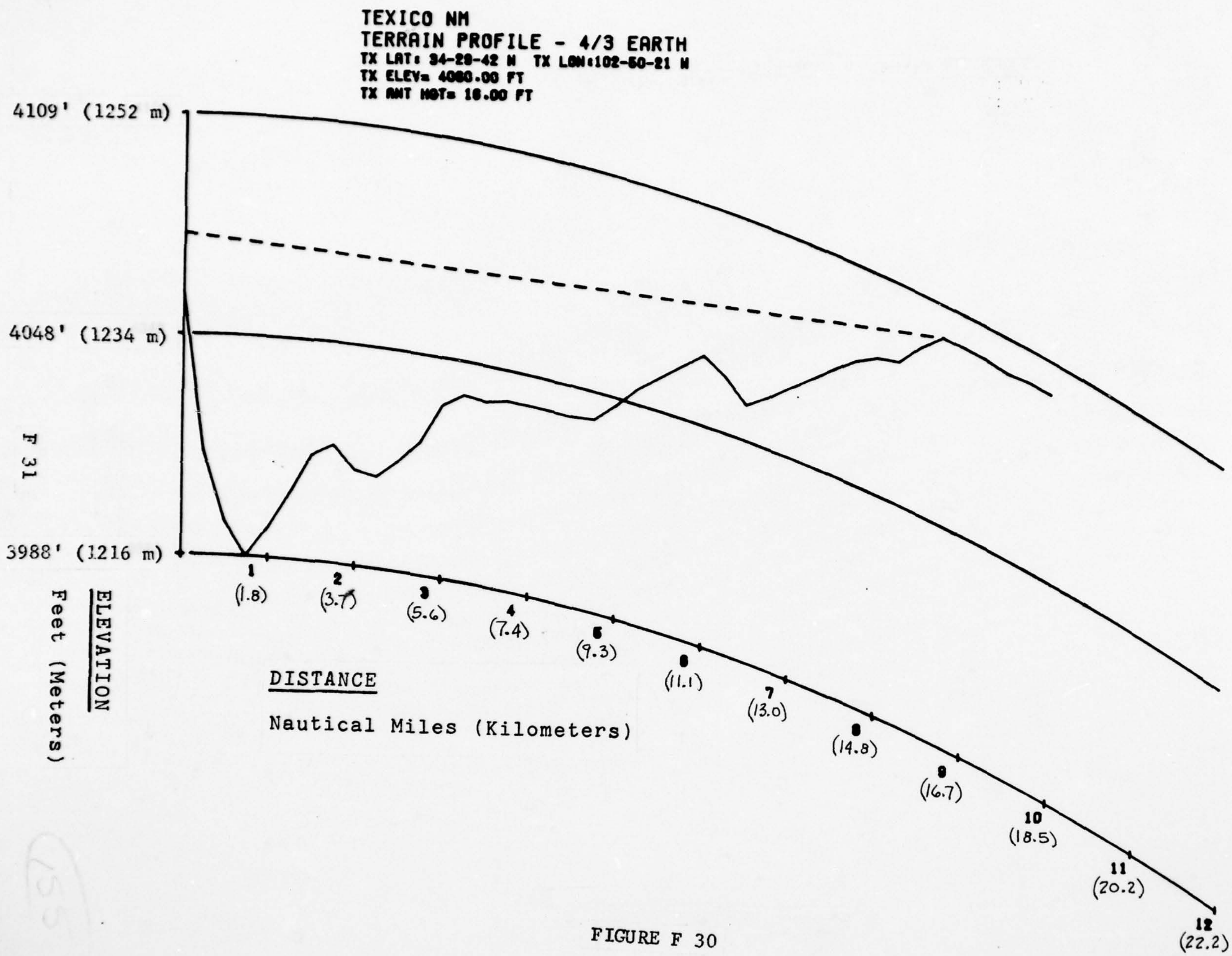

TEXICO NM
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 34-29-42 N TX LON:102-50-21 W
TX ELEV= 4060.00 FT
TX ANT HGT= 16.00 FT
4109' (1252 m)
4048' (1234 m)
3988' (1216 m)
ELEVATION
Feet (Meters)
DISTANCE
Nautical Miles (Kilometers)
1 (1.8)
2 (3.7)
3 (5.6)
4 (7.4)
5 (9.3)
6 (11.1)
7 (13.0)
8 (14.8)
9 (16.7)
10 (18.5)
11 (20.2)
12 (22.2)

FIGURE F 30

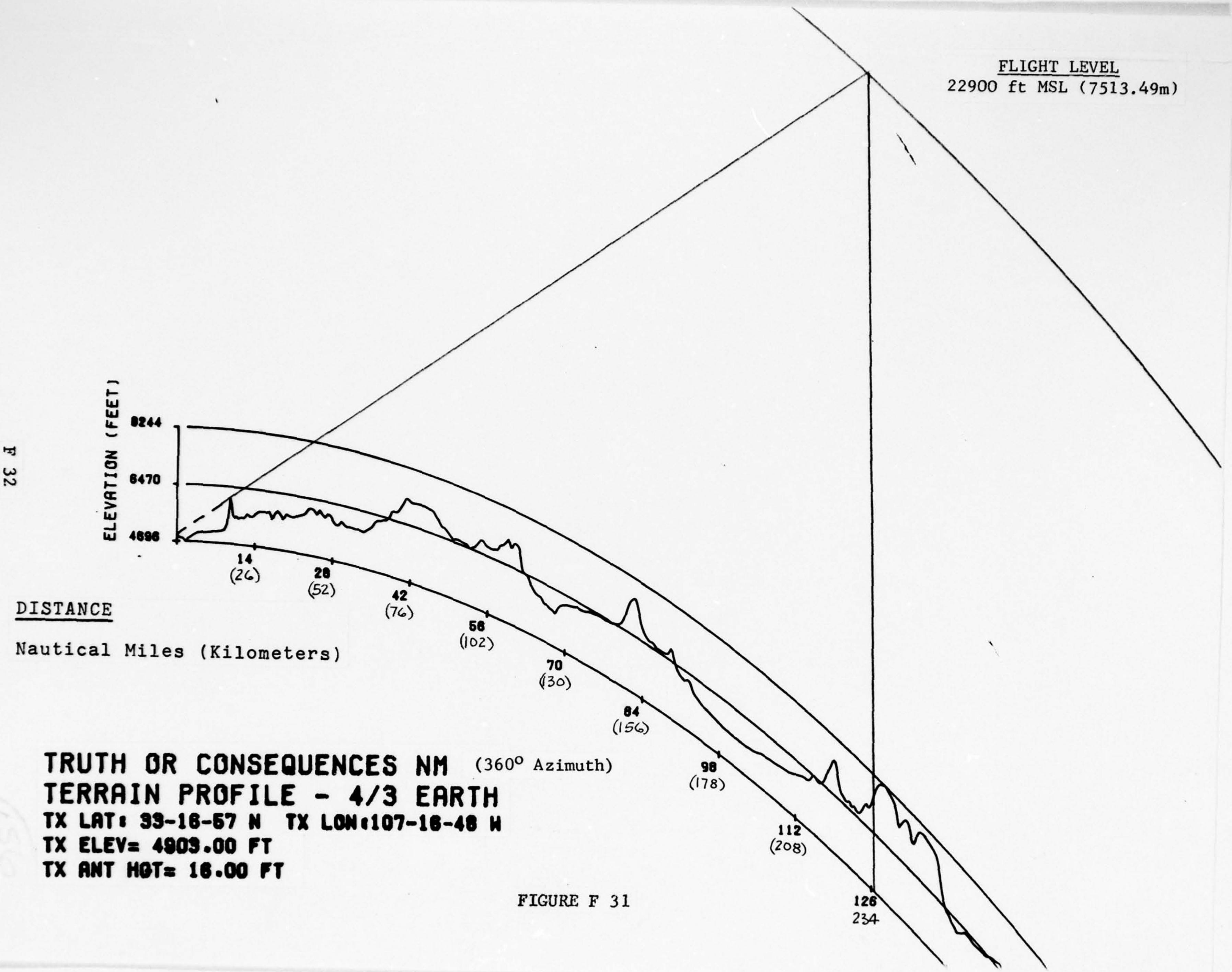

FLIGHT LEVEL
22900 ft MSL (7513.49m)
ELEVATION (FEET)
8244
6470
4696
14
(26)
28
(52)
42
(76)
56
(102)
70
(130)
84
(156)
98
(178)
112
(208)
126
234
DISTANCE
Nautical Miles (Kilometers)
TRUTH OR CONSEQUENCES NM (360° Azimuth)
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 33-16-57 N TX LON:107-16-48 W
TX ELEV= 4903.00 FT
TX ANT HGT= 16.00 FT

FIGURE F 31

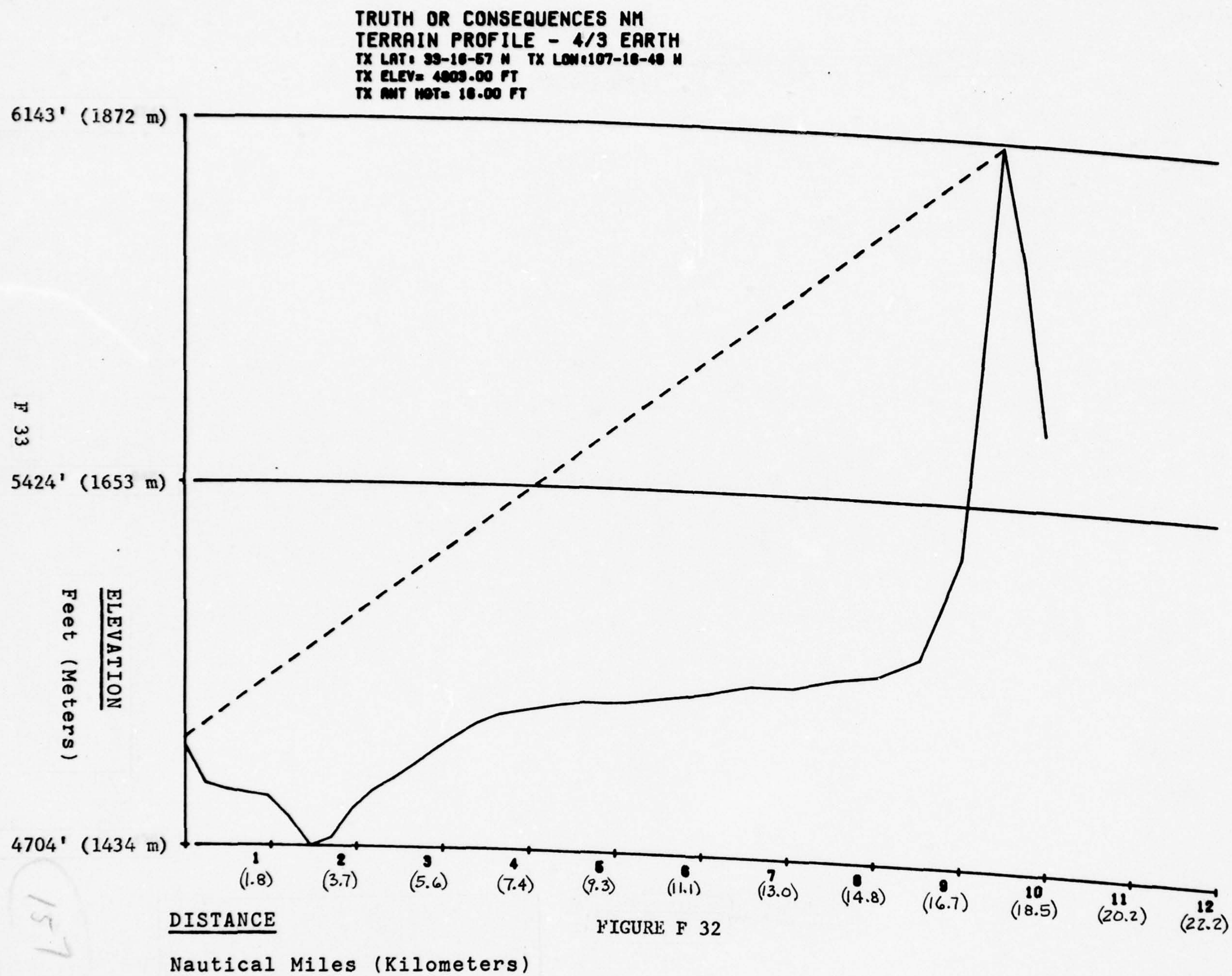
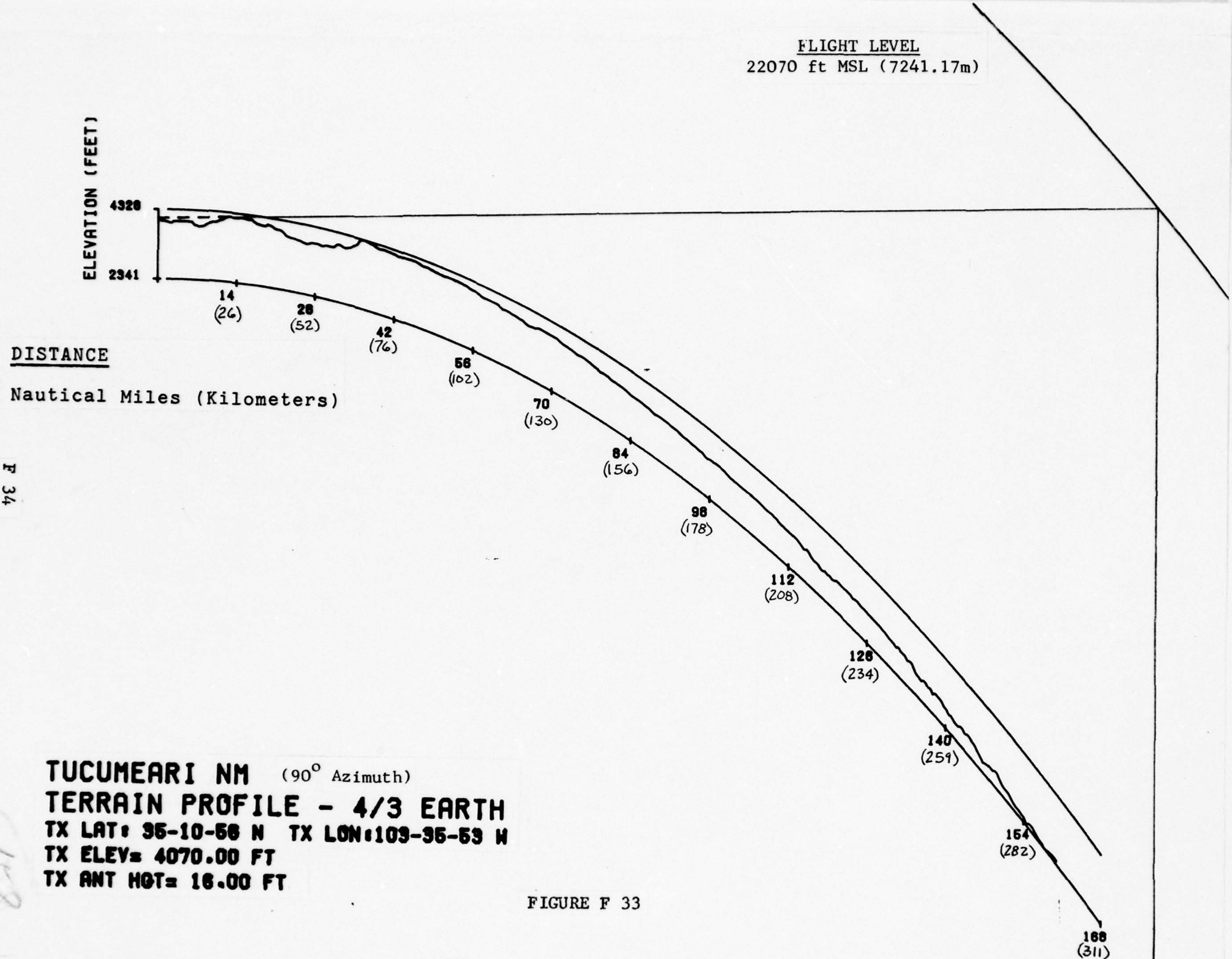


FIGURE F 32

157



TUCUMEARI NM (90° Azimuth)
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 35-10-56 N TX LON:103-35-53 W
TX ELEV= 4070.00 FT
TX ANT HGT= 16.00 FT

FIGURE F 33

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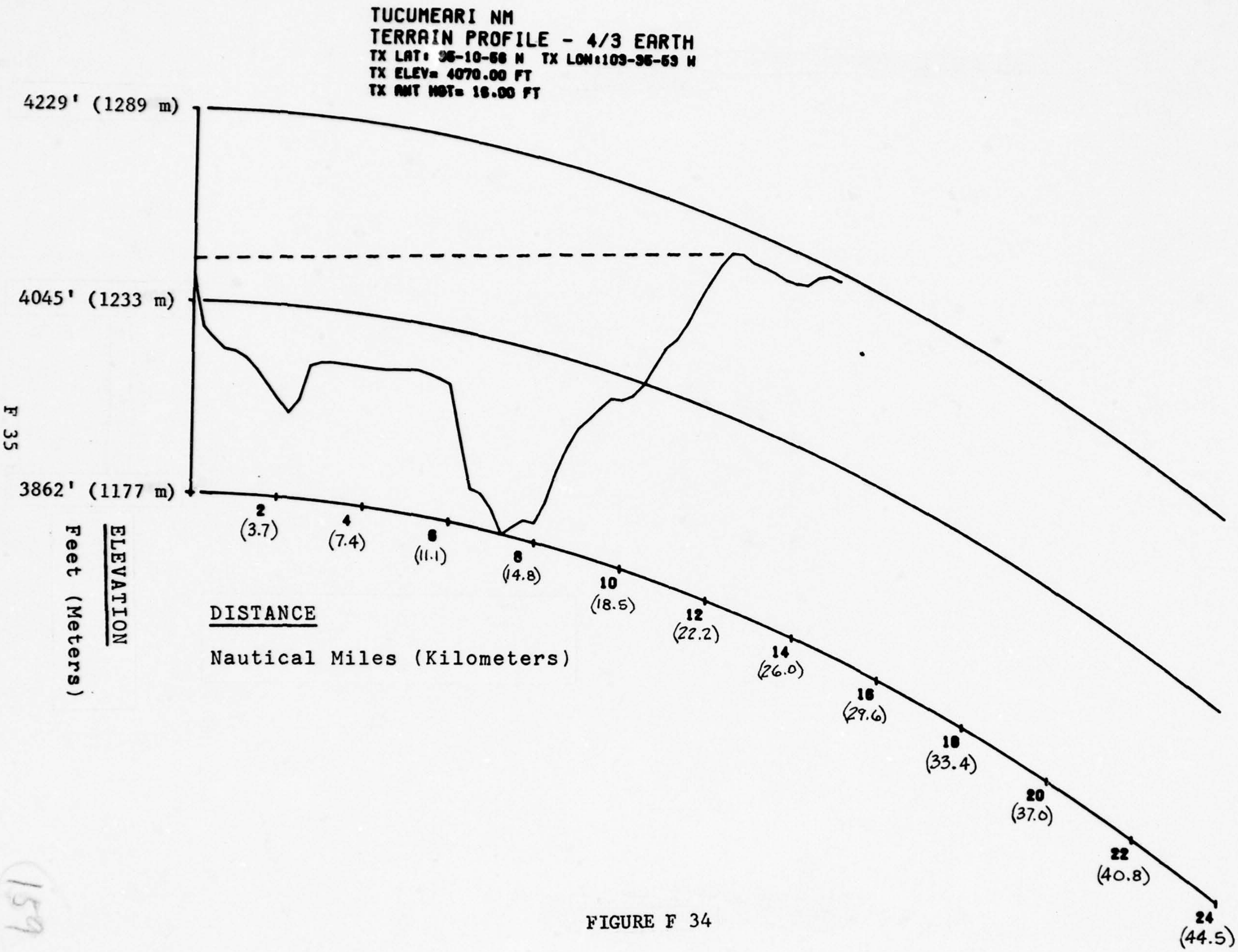
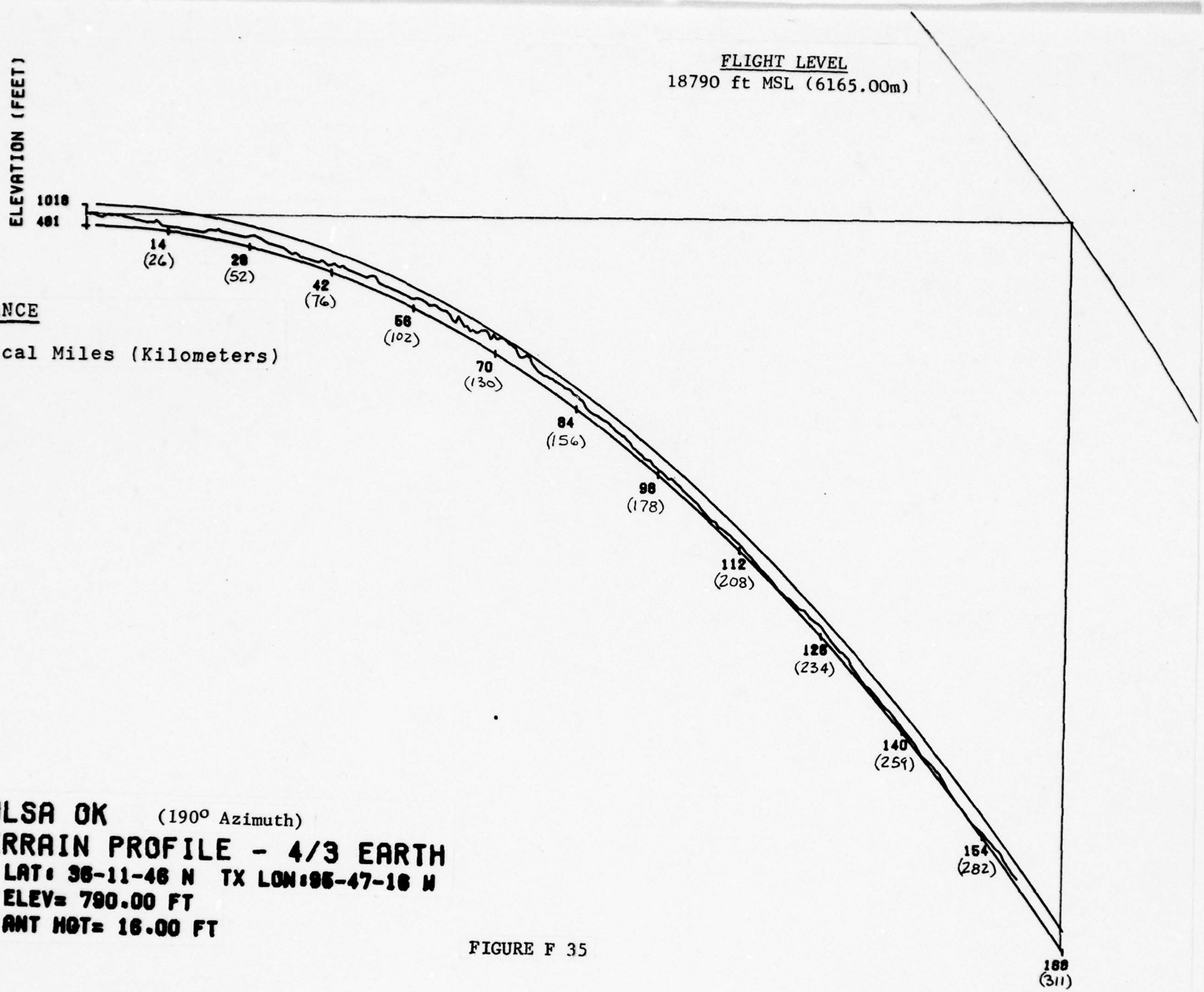

TUCUMEARI NM
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 35-10-56 N TX LON:103-36-53 W
TX ELEV= 4070.00 FT
TX ANT HGT= 16.00 FT
4229' (1289 m)
4045' (1233 m)
3862' (1177 m)
ELEVATION
Feet (Meters)
DISTANCE
Nautical Miles (Kilometers)
2 (3.7)
4 (7.4)
6 (11.1)
8 (14.8)
10 (18.5)
12 (22.2)
14 (26.0)
16 (29.6)
18 (33.4)
20 (37.0)
22 (40.8)
24 (44.5)

FIGURE F 34



TULSA OK (190° Azimuth)
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 36-11-46 N TX LON:95-47-18 W
TX ELEV= 790.00 FT
TX ANT HGT= 16.00 FT

FIGURE F 35

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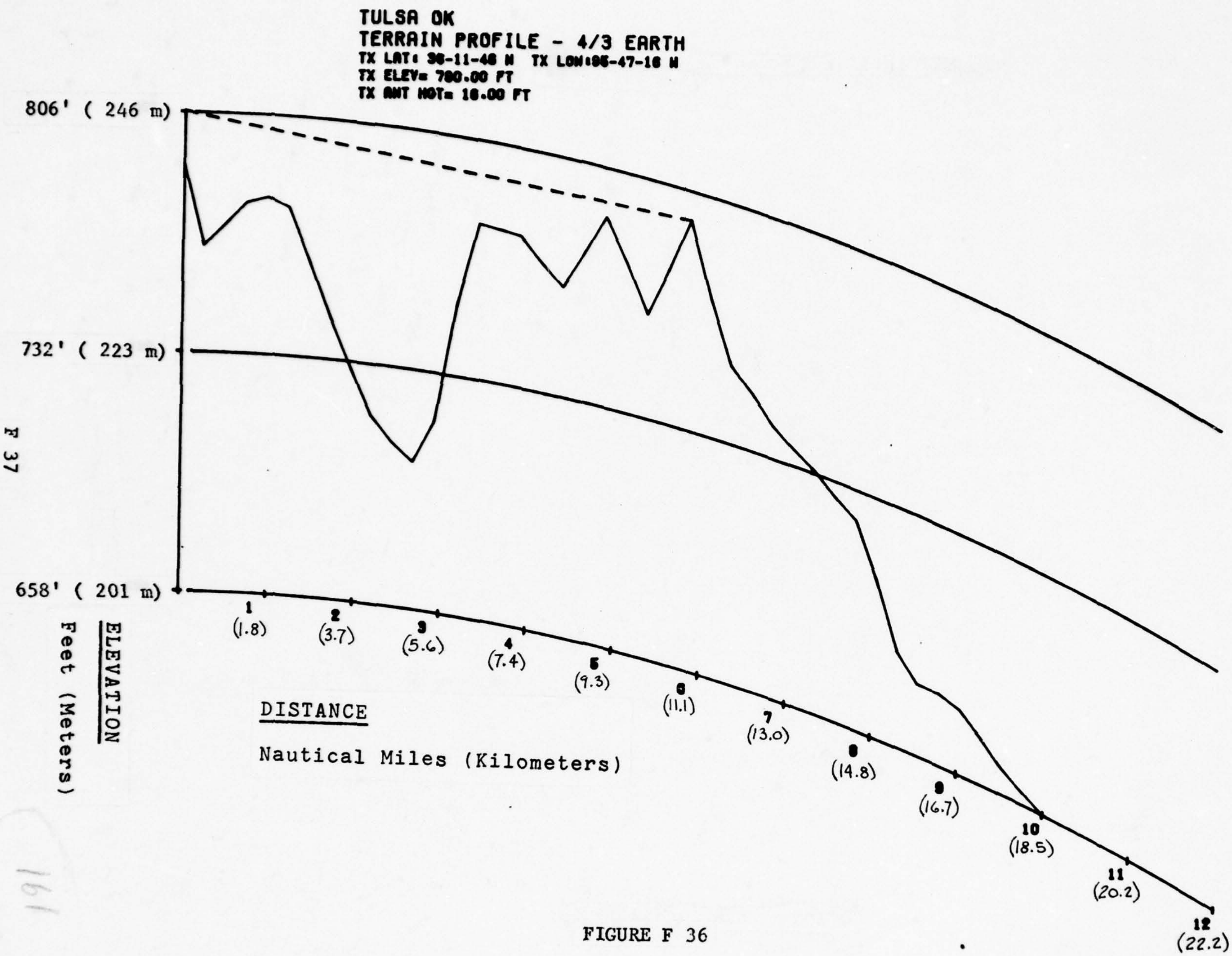
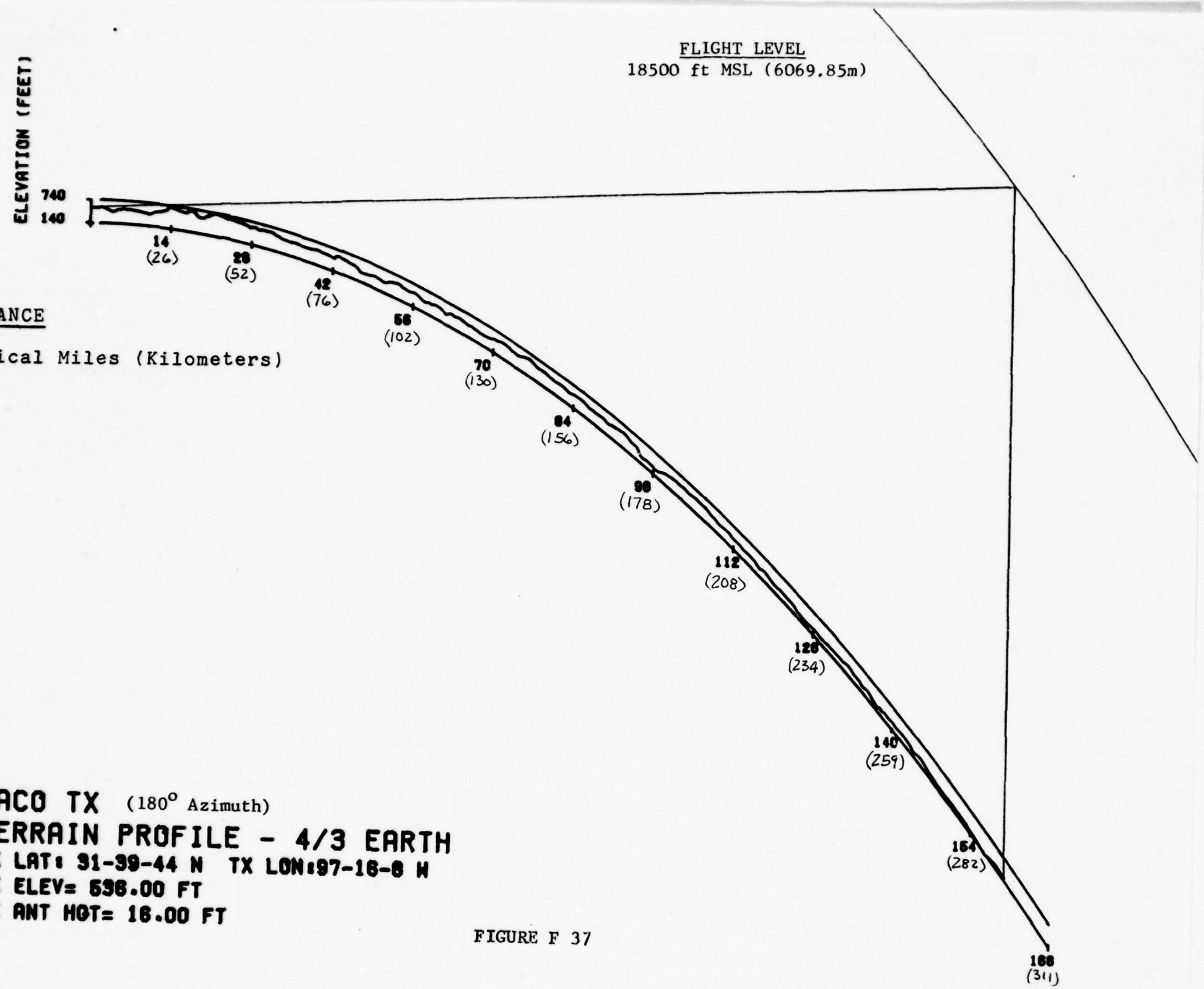

TULSA OK
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 36-11-46 N TX LON:95-47-16 W
TX ELEV= 780.00 FT
TX ANT HGT= 16.00 FT
806' (246 m)
732' (223 m)
658' (201 m)
ELEVATION
Feet (Meters)
DISTANCE
Nautical Miles (Kilometers)
1 (1.8)
2 (3.7)
3 (5.6)
4 (7.4)
5 (9.3)
6 (11.1)
7 (13.0)
8 (14.8)
9 (16.7)
10 (18.5)
11 (20.2)
12 (22.2)

FIGURE F 36



WACO TX (180° Azimuth)
TERRAIN PROFILE - 4/3 EARTH
TX LAT: 31-39-44 N TX LON:97-16-8 W
TX ELEV= 536.00 FT
TX ANT HGT= 16.00 FT

FIGURE F 37

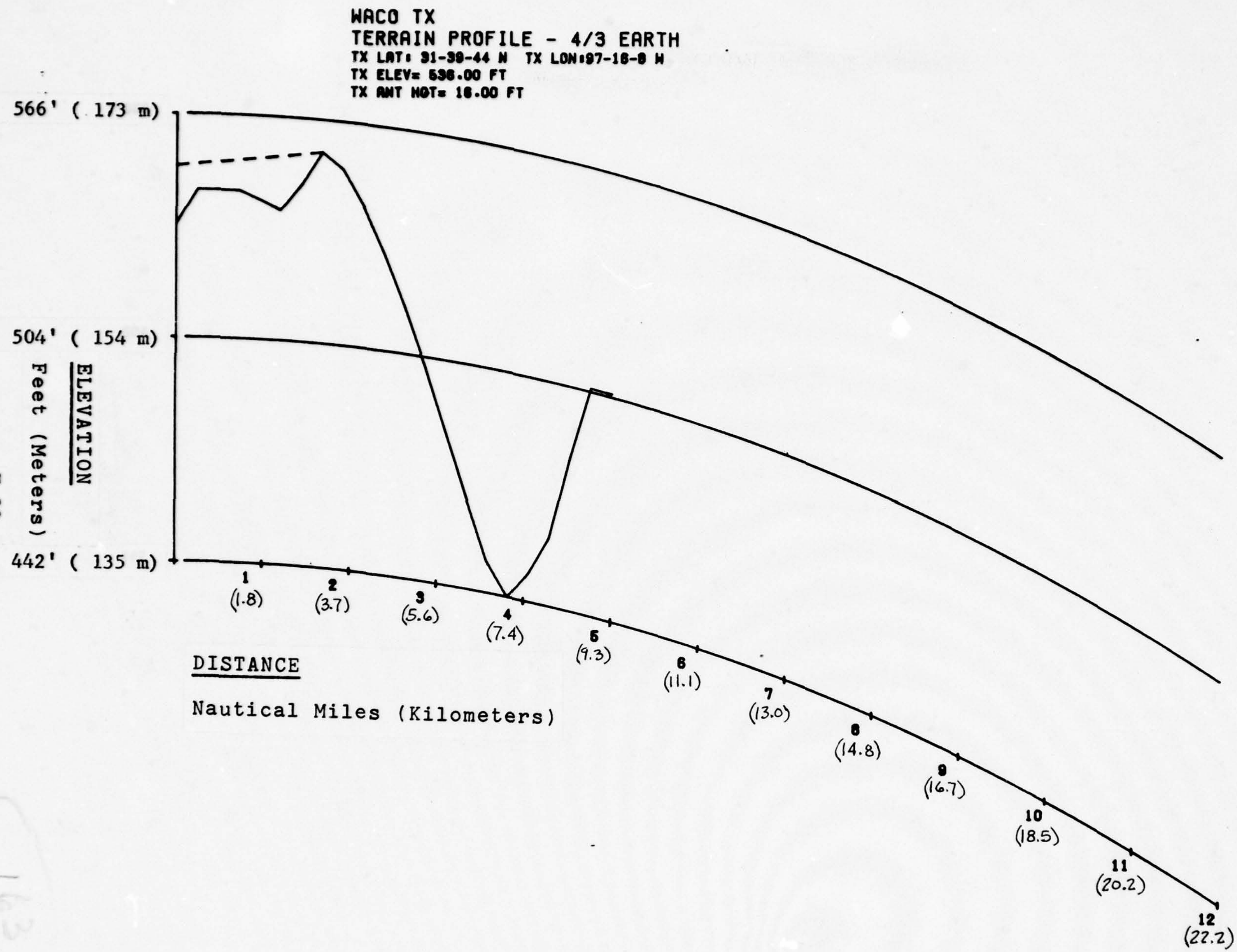


FIGURE F 38

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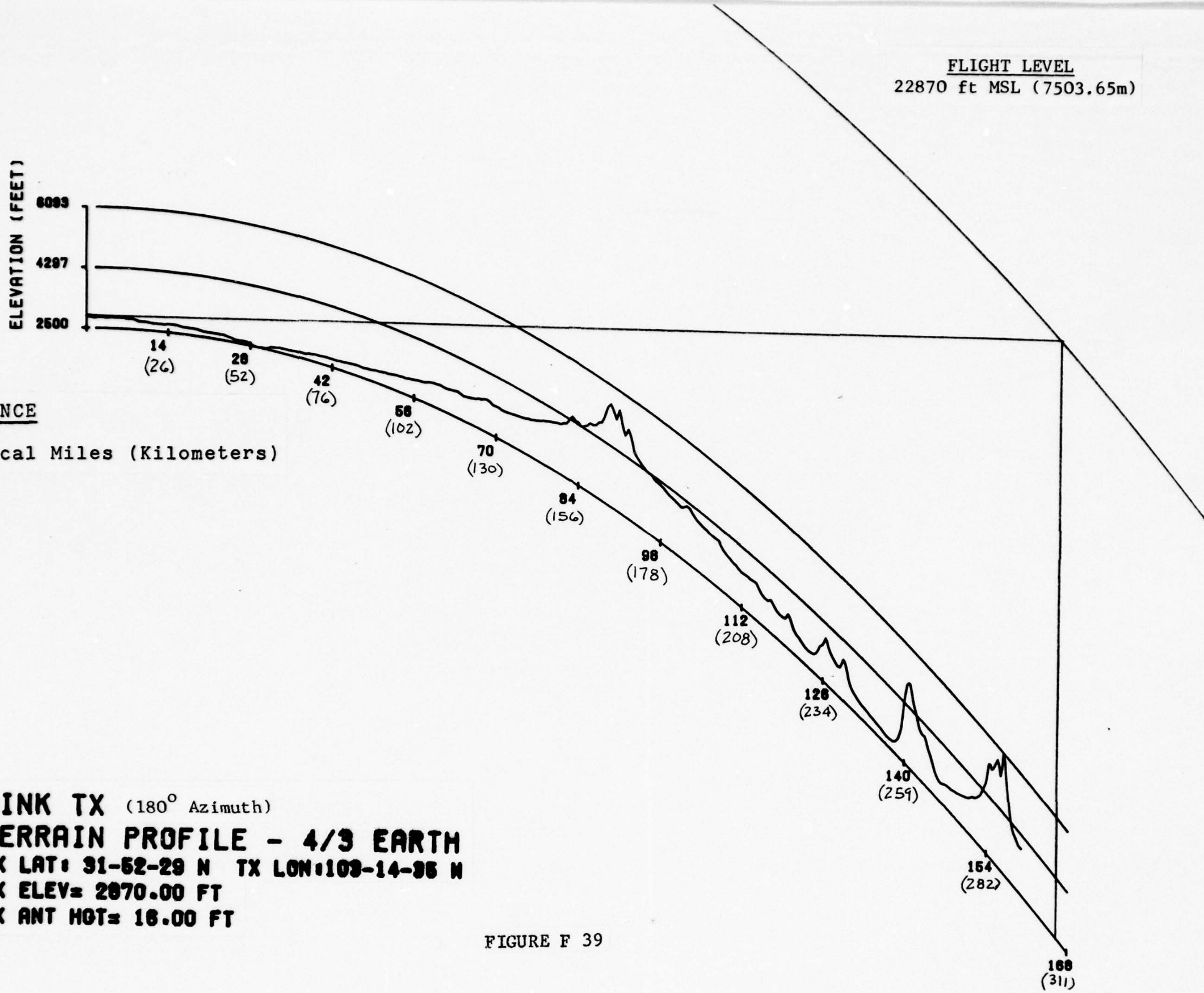

DISTANCE

Nautical Miles (Kilometers)

F 40

WINK TX (180° Azimuth)

TERRAIN PROFILE - 4/3 EARTH

TX LAT: 31-52-29 N TX LON:103-14-35 W

TX ELEV= 2870.00 FT

TX ANT HGT= 16.00 FT

FIGURE F 39

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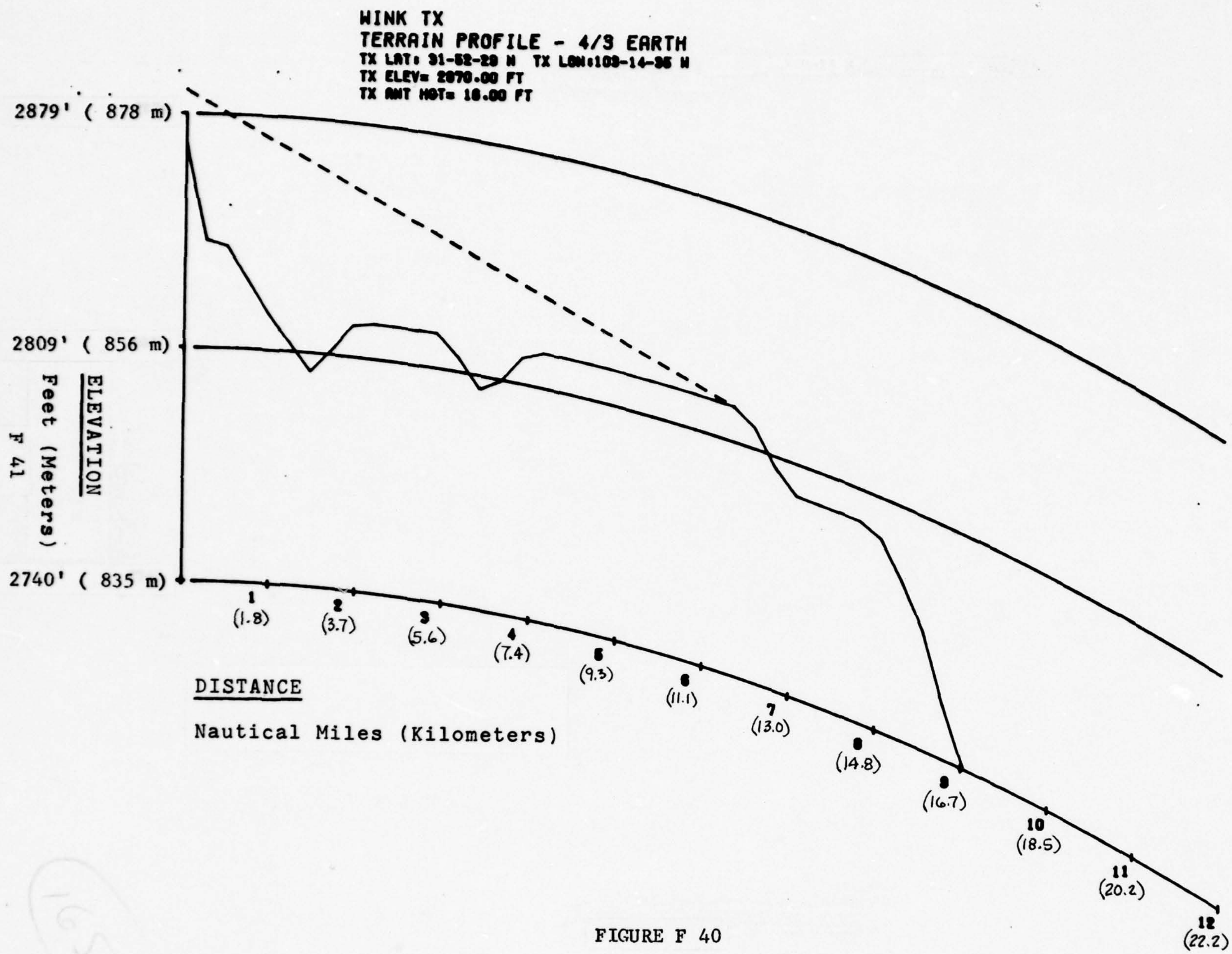

FIGURE F 40

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TABLE F-1
HORIZON PARAMETERS
From ECAC Terrain Files

	Distance In nmi (Km)	Elevation (MSL) In Feet (m)
Abilene, Tx.	12.3 (22.8)	2390' (728)
Albuquerque, N.M.	14.8 (27.4)	5471' (1668)
Amarillo, Tx.	12.5 (23.2)	3440' (1049)
Cimarron, N.M.	35.5 (65.7)	6239' (1902)
El Paso, Tx.	30.0 (55.6)	5208' (1587)
Greater Southwest, Tx.	23.3 (43.2)	855' (261)
Junction, Tx.	24.3 (45.0)	2195' (669)
Las Vegas, N.M.	8.8 (16.3)	6900' (2103)
Millsap, Tx.	4.5 (8.3)	852' (260)
Oklahoma City, Ok.	4.5 (8.3)	1382' (421)
Pioneer, Ok.	11.3 (20.9)	980' (299)
Roswell, N.M.	25.2 (46.7)	3698' (1127)
San Angelo, Tx.	14.3 (26.5)	2245' (684)
San Antonio, Tx.	28.0 (51.9)	788' (240)
Texico, Tx.	8.8 (16.3)	4100' (1250)
Truth or Consequences, N.M.	9.5 (17.6)	6102' (1860)
Tucumeari, N.M.	12.5 (23.2)	4201' (1280)
Tulsa, Ok.	5.8 (10.7)	791' (241)
Waco, Tx.	1.8 (3.3)	559' (170)
Wink, Tx.	6.5 (12.0)	2819' (859)

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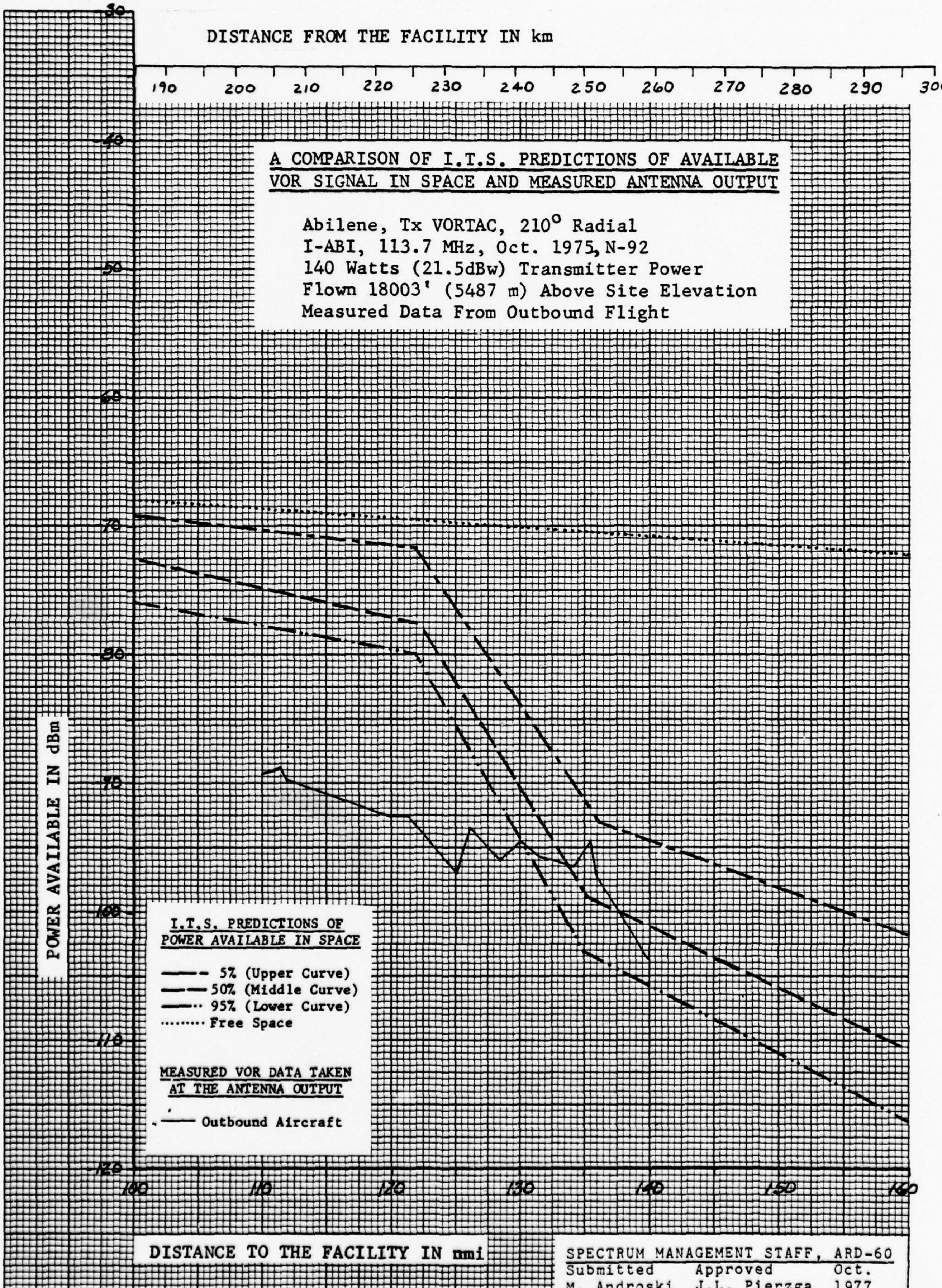
APPENDIX G

COMPARISON OF ITS PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE (CONSIDERING LOCAL TERRAIN) AND MEASURED ANTENNA OUTPUT (PLOTTED IN dBw)

The measured VOR data shown in this Appendix are identical to the data given in Appendix A. The ITS predictions of available VOR signal are different. In this Appendix, the predictions attempt to take into account the different terrain on the azimuth flown for each VORTAC. Terrain profiles, based on the ECAC terrain files, are shown in Appendix F. These graphs were drawn by a computer model which also provides a digital printout of the data. A summary of the digital outputs of the horizon parameters is shown in Table F-1, page F- 2. These values were used as input parameters for the ITS/FAA model. The resulting model outputs are shown in Appendix I.



DISTANCE FROM THE FACILITY IN km
190 200 210 220 230 240 250 260 270 280 290 300
A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Abilene, Tx VORTAC, 210° Radial
I-ABI, 113.7 MHz, Oct. 1975, N-92
140 Watts (21.5dBw) Transmitter Power
Flown 18003' (5487 m) Above Site Elevation
Measured Data From Outbound Flight
-30 -40 -50 -60 -70 -80 -90 -100 -110 -120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
100 110 120 130 140 150 160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved Oct.
M. Androski J.L. Pierzga 1977

FIGURE G 1

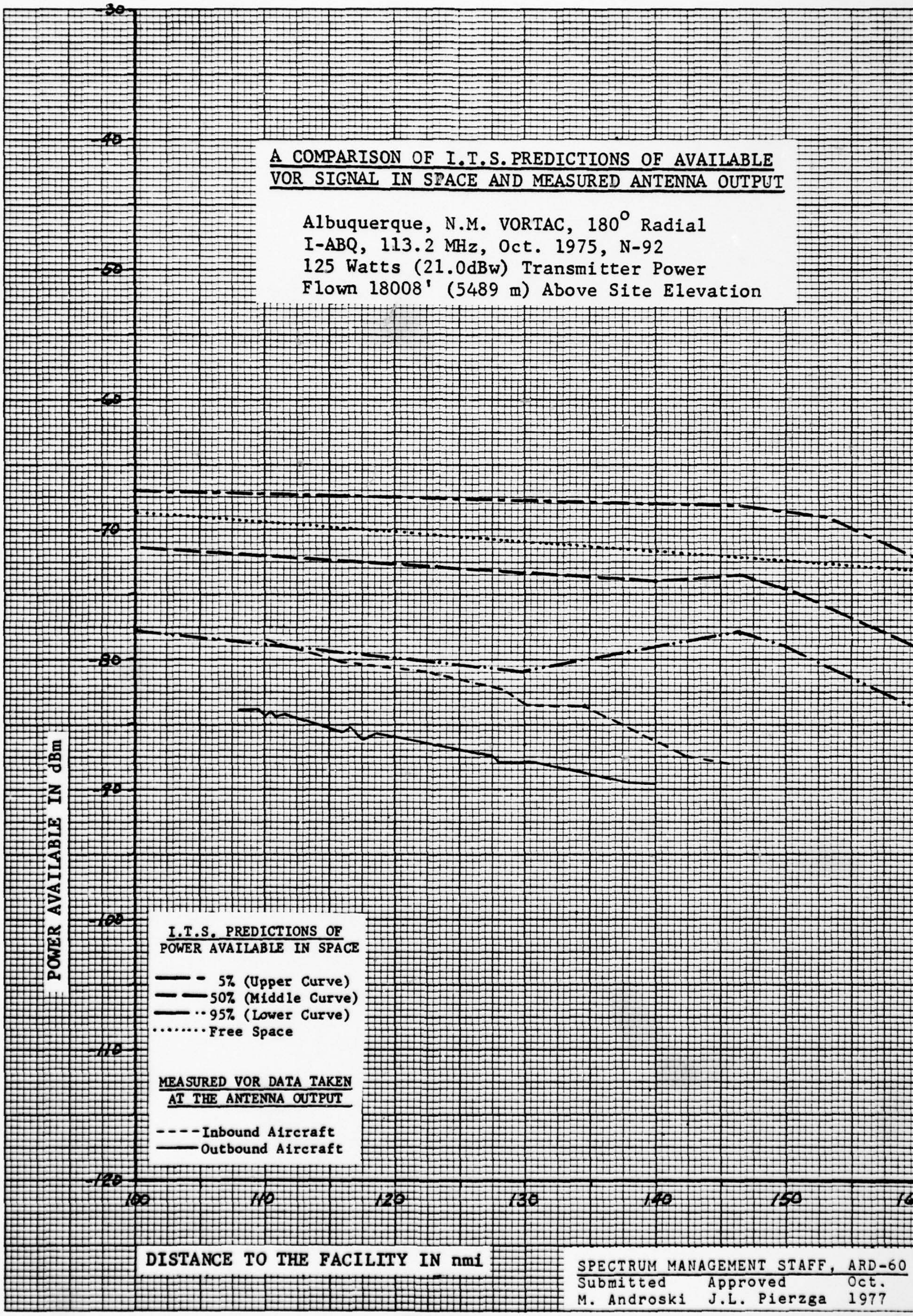

A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Albuquerque, N.M. VORTAC, 180° Radial
I-ABQ, 113.2 MHz, Oct. 1975, N-92
125 Watts (21.0dBw) Transmitter Power
Flown 18008' (5489 m) Above Site Elevation
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
SPECTRUM MANAGEMENT STAFF, ARD-60
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FIGURE G 2

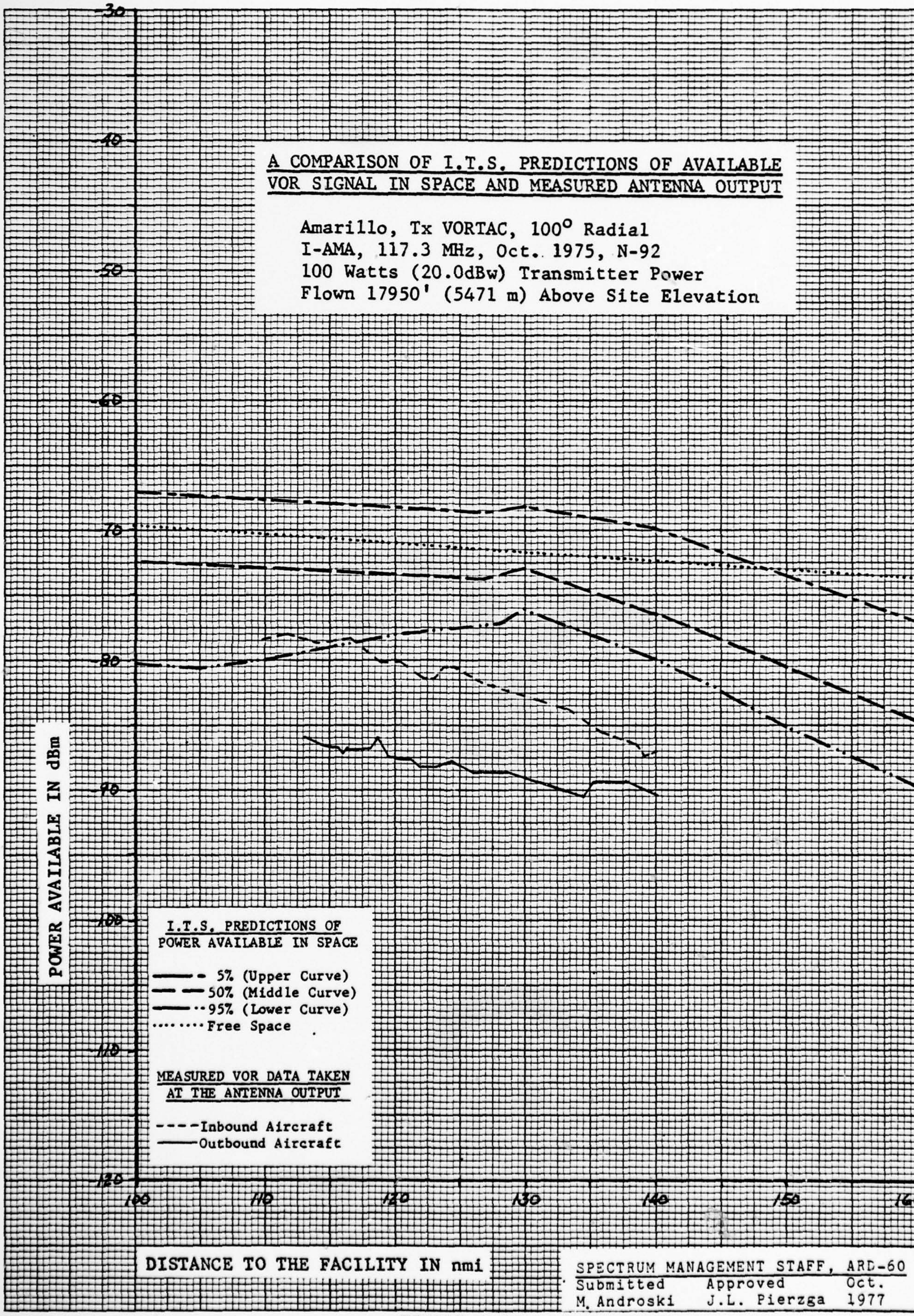
A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Amarillo, Tx VORTAC, 100° Radial
I-AMA, 117.3 MHz, Oct. 1975, N-92
100 Watts (20.0dBw) Transmitter Power
Flown 17950' (5471 m) Above Site Elevation
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
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FIGURE G 3

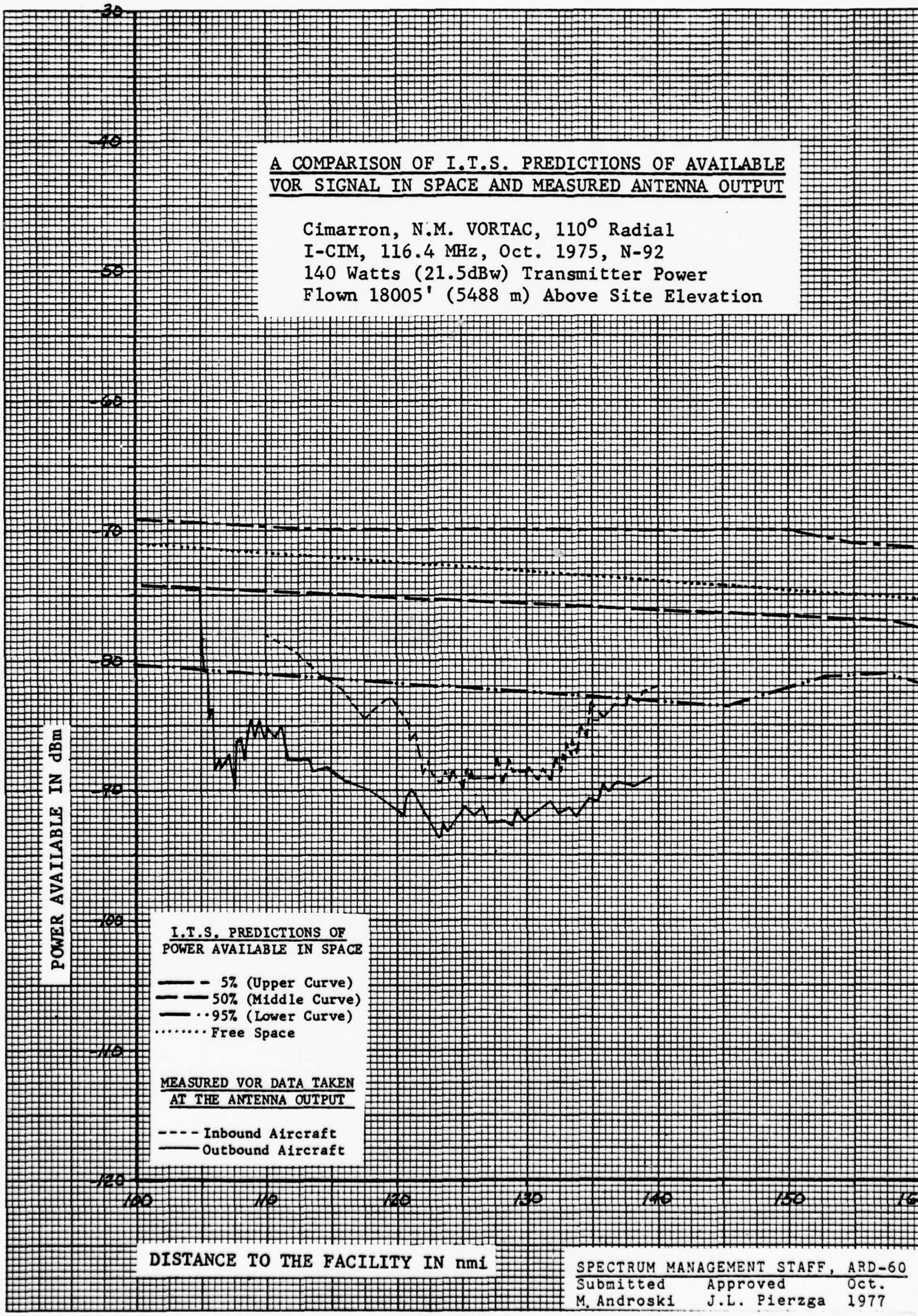
A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Cimarron, N.M. VORTAC, 110° Radial
I-CIM, 116.4 MHz, Oct. 1975, N-92
140 Watts (21.5dBw) Transmitter Power
Flown 18005' (5488 m) Above Site Elevation
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted M. Androski
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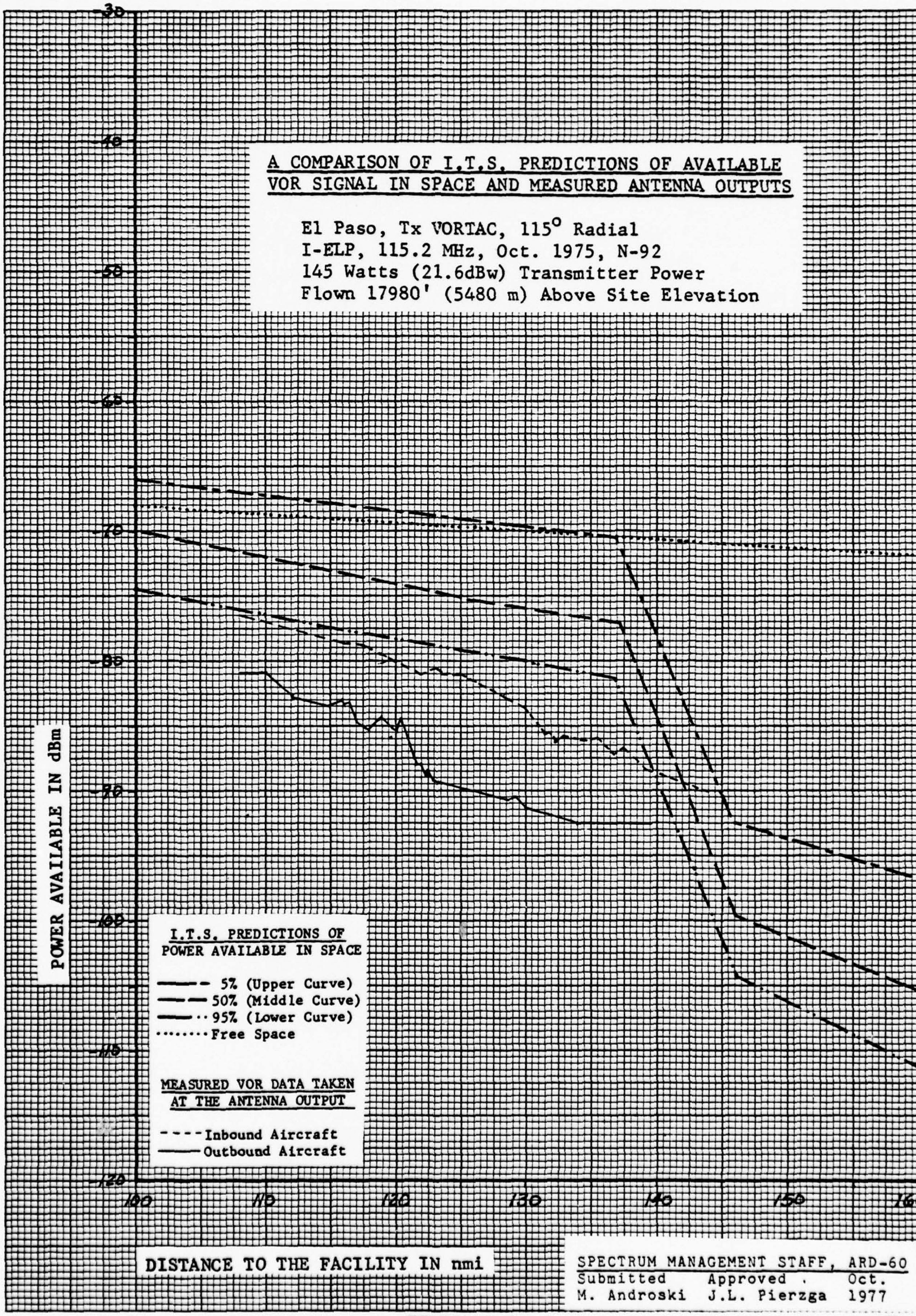
FIGURE G 4



-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
100
110
120
130
140
150
160
POWER AVAILABLE IN dBm
DISTANCE TO THE FACILITY IN nmi
A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUTS
El Paso, Tx VORTAC, 115° Radial
I-ELP, 115.2 MHz, Oct. 1975, N-92
145 Watts (21.6dBw) Transmitter Power
Flown 17980' (5480 m) Above Site Elevation
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
SPECTRUM MANAGEMENT STAFF, ARD-60
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FIGURE G 5

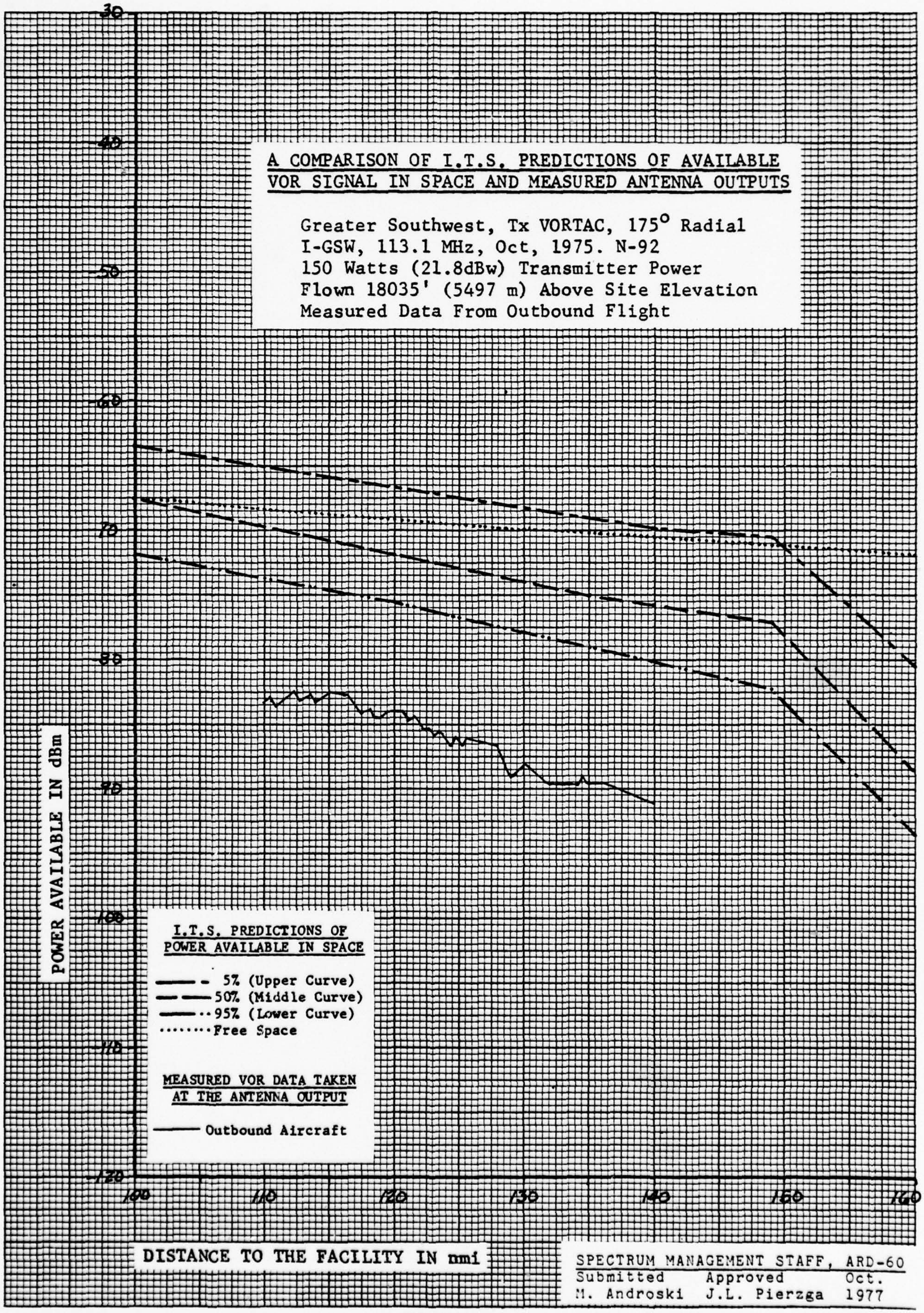
A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUTS
Greater Southwest, Tx VORTAC, 175° Radial
I-GSW, 113.1 MHz, Oct, 1975. N-92
150 Watts (21.8dBw) Transmitter Power
Flown 18035' (5497 m) Above Site Elevation
Measured Data From Outbound Flight
POWER AVAILABLE IN dBm
DISTANCE TO THE FACILITY IN nmi
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
SPECTRUM MANAGEMENT STAFF, ARD-60
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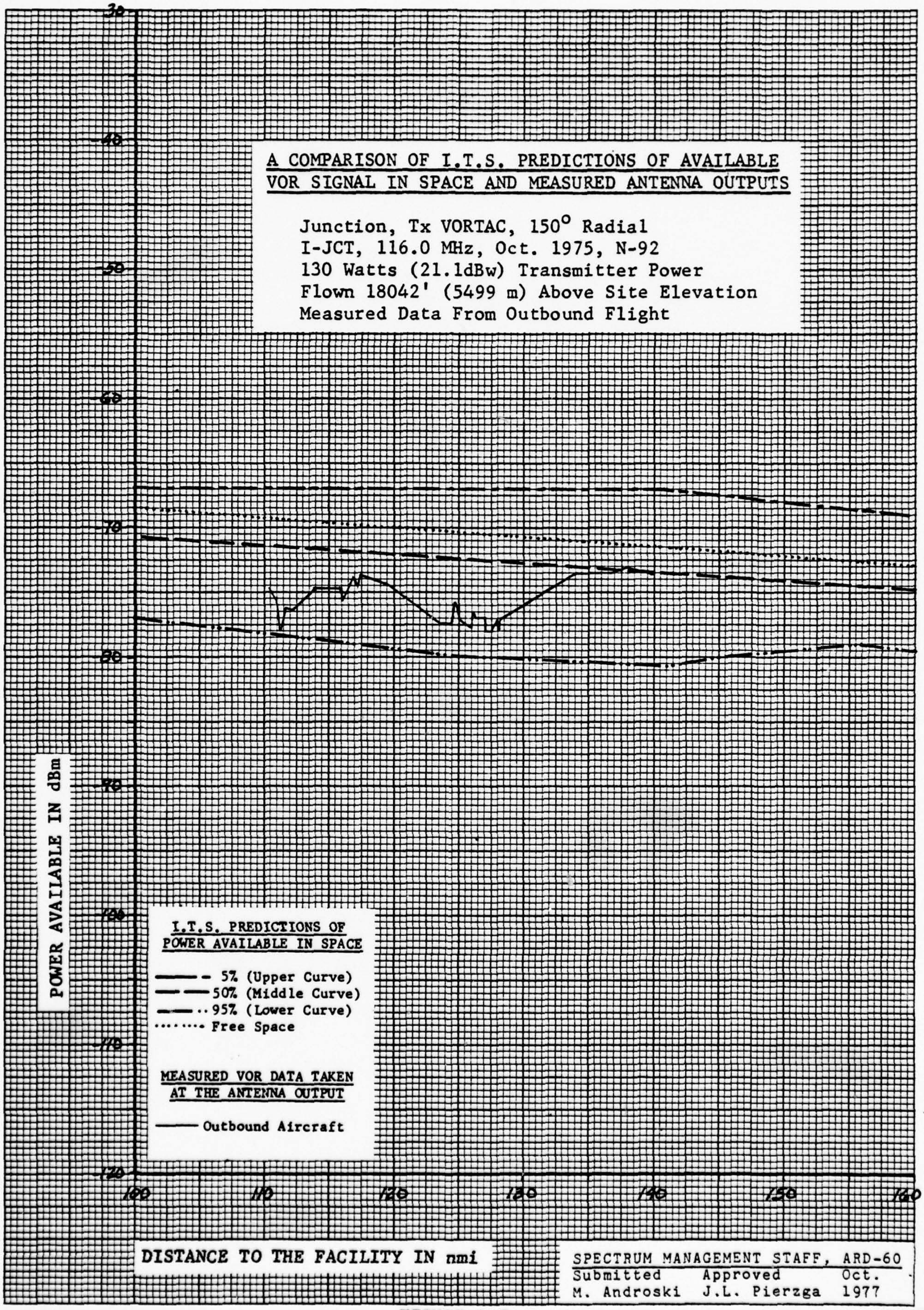
FIGURE G 6



A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUTS
Junction, Tx VORTAC, 150° Radial
I-JCT, 116.0 MHz, Oct. 1975, N-92
130 Watts (21.1dBw) Transmitter Power
Flown 18042' (5499 m) Above Site Elevation
Measured Data From Outbound Flight
POWER AVAILABLE IN dBm
30
40
50
60
70
80
90
100
110
120
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted M. Androski
Approved J.L. Pierzga
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FIGURE G 7

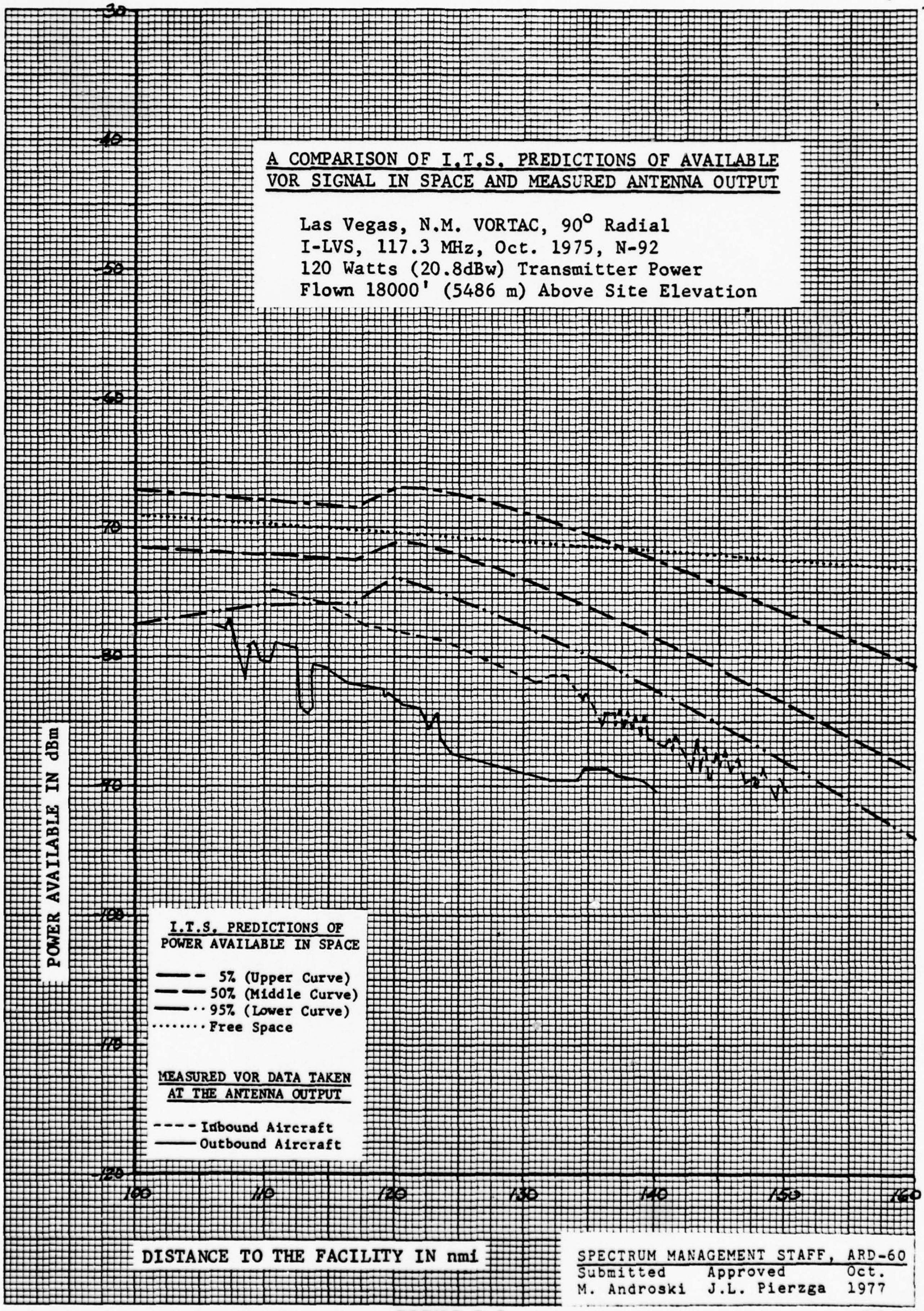
A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Las Vegas, N.M. VORTAC, 90° Radial
I-LVS, 117.3 MHz, Oct. 1975, N-92
120 Watts (20.8dBw) Transmitter Power
Flown 18000' (5486 m) Above Site Elevation
POWER AVAILABLE IN dBm
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
100
110
120
130
140
150
160
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
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FIGURE G 8

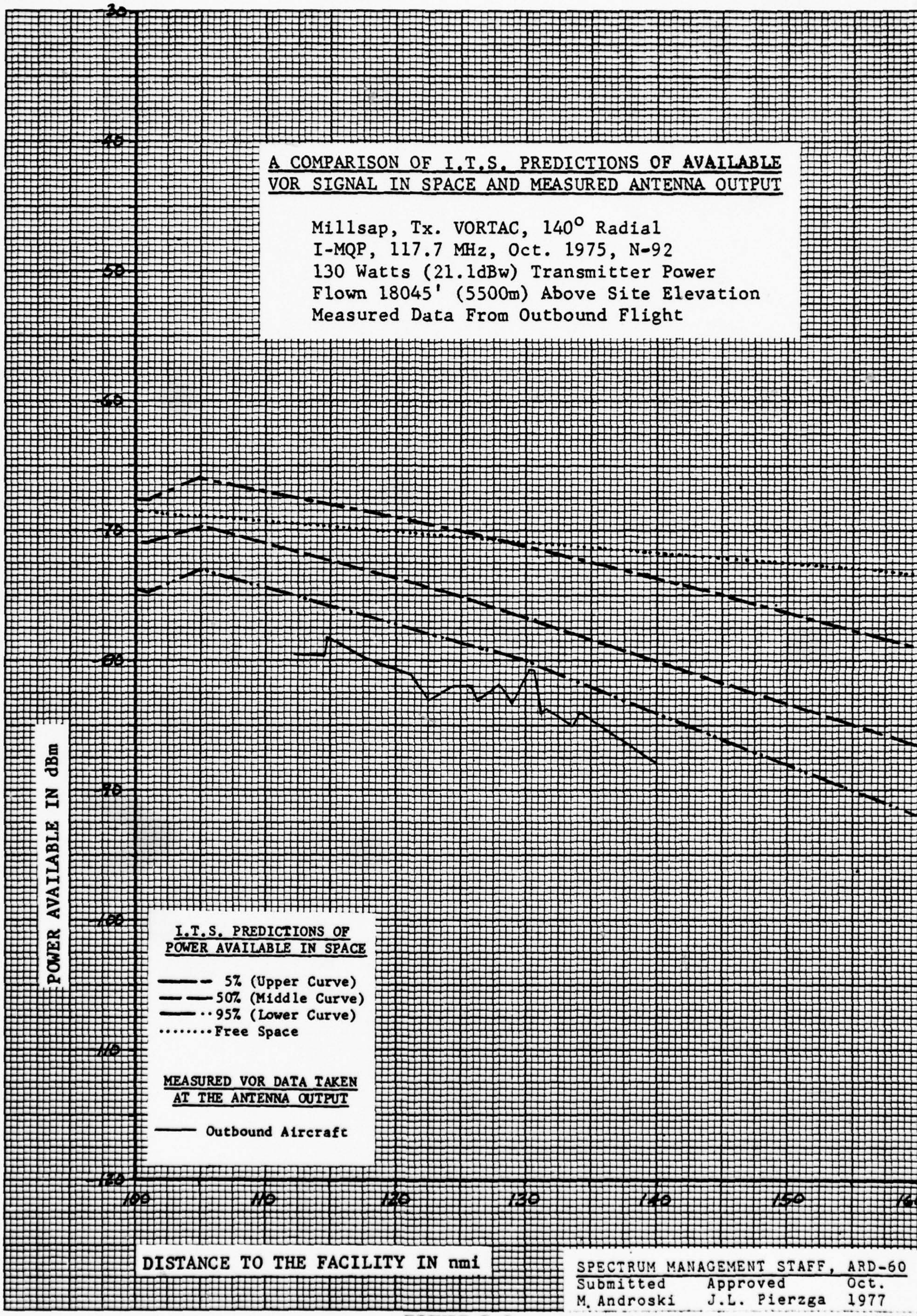
A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Millsap, Tx. VORTAC, 140° Radial
I-MQP, 117.7 MHz, Oct. 1975, N-92
130 Watts (21.1dBw) Transmitter Power
Flown 18045' (5500m) Above Site Elevation
Measured Data From Outbound Flight
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
POWER AVAILABLE IN dBm
30
40
50
60
70
80
90
100
110
120
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
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FIGURE G 9

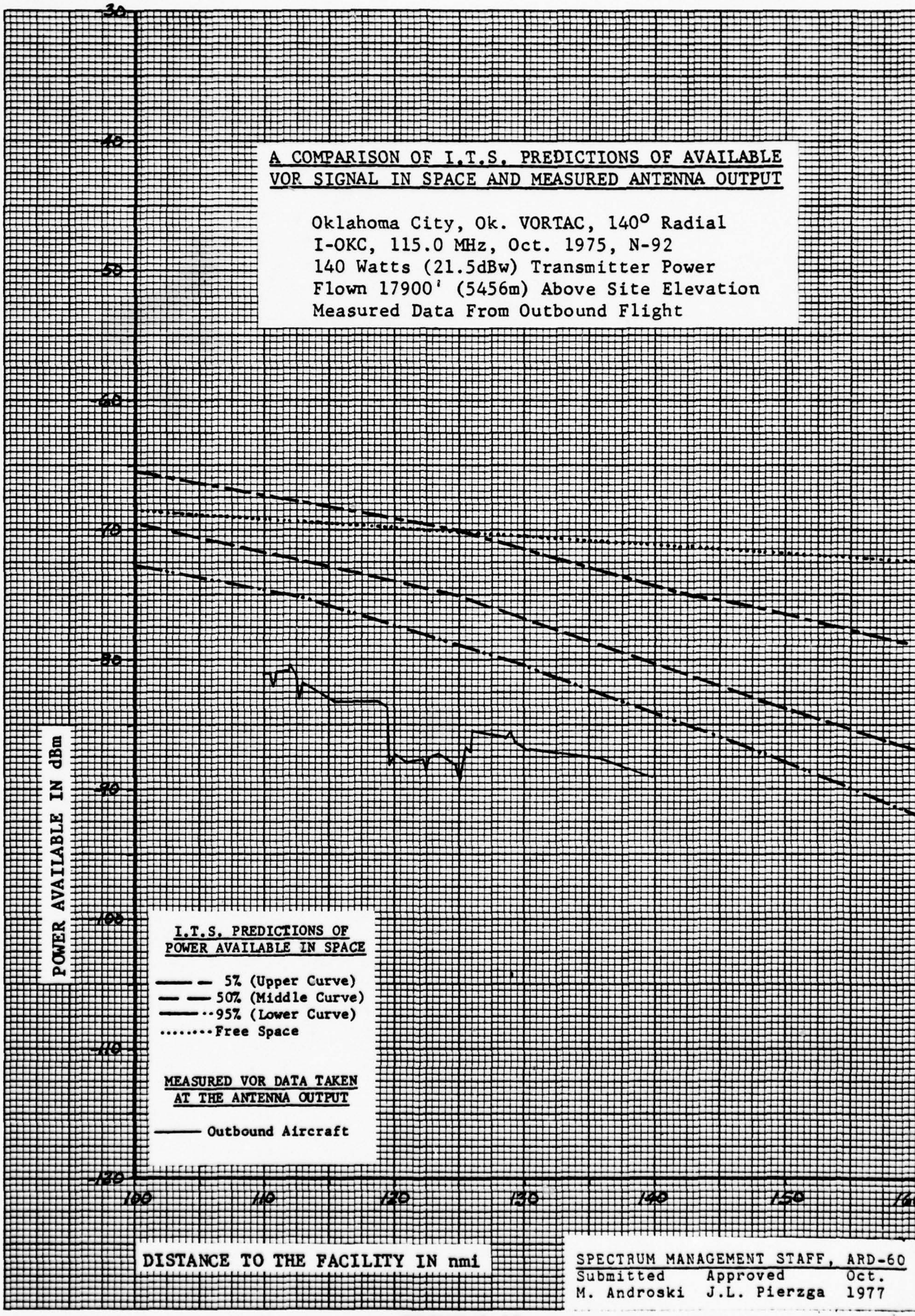

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FIGURE G 10

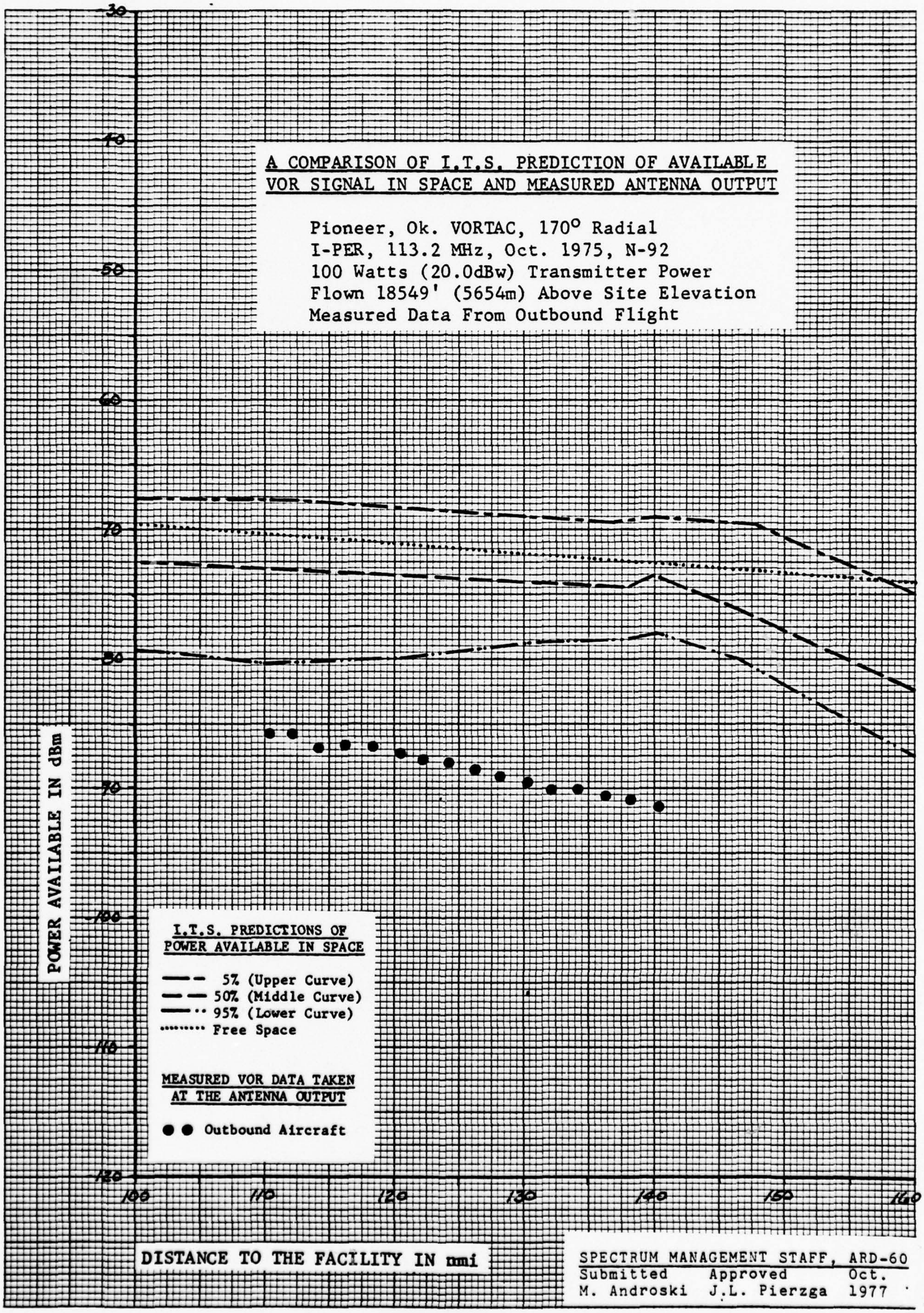
A COMPARISON OF I.T.S. PREDICTION OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Pioneer, Ok. VORTAC, 170° Radial
I-PER, 113.2 MHz, Oct. 1975, N-92
100 Watts (20.0dBw) Transmitter Power
Flown 18549' (5654m) Above Site Elevation
Measured Data From Outbound Flight
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
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FIGURE G 11

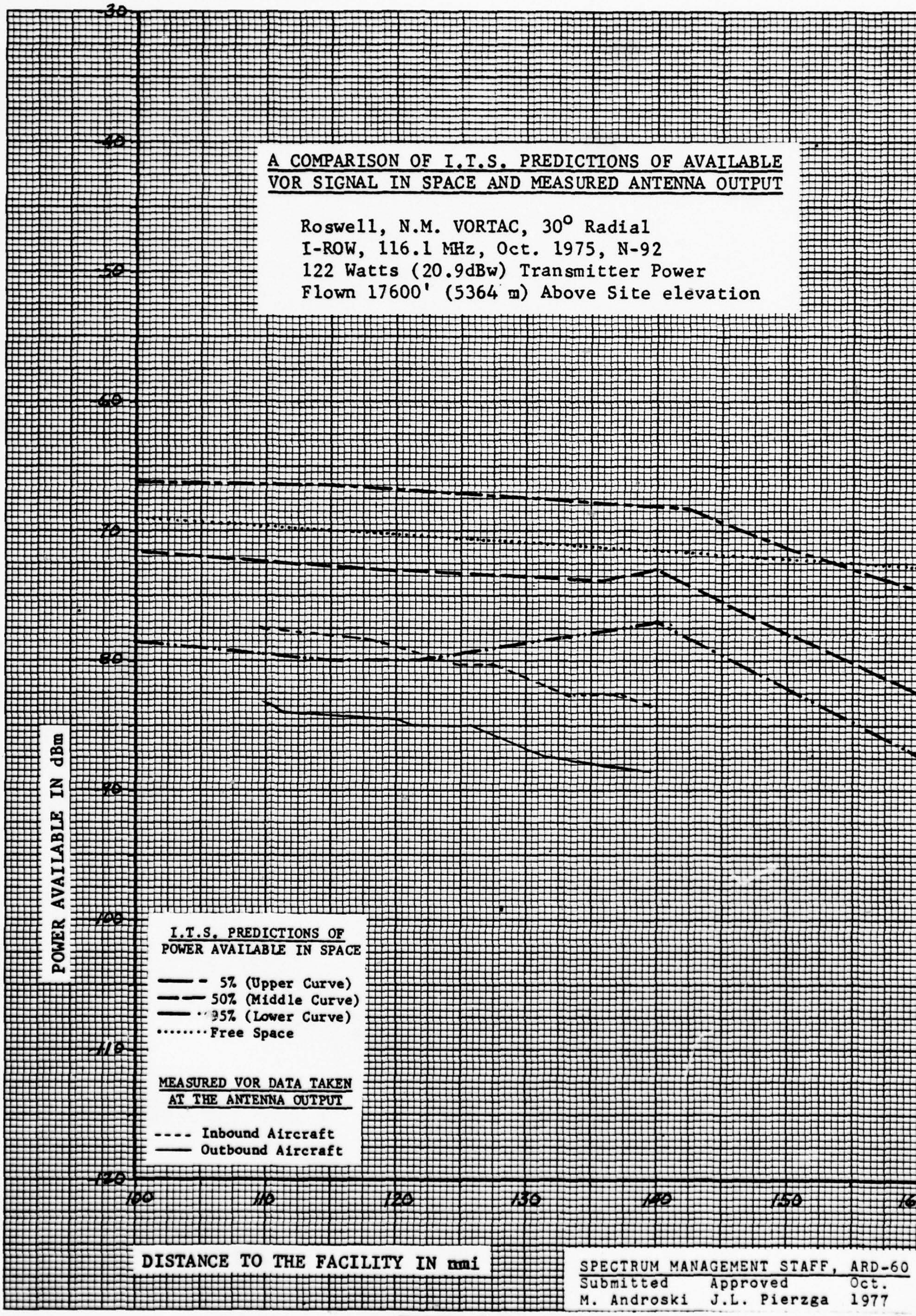
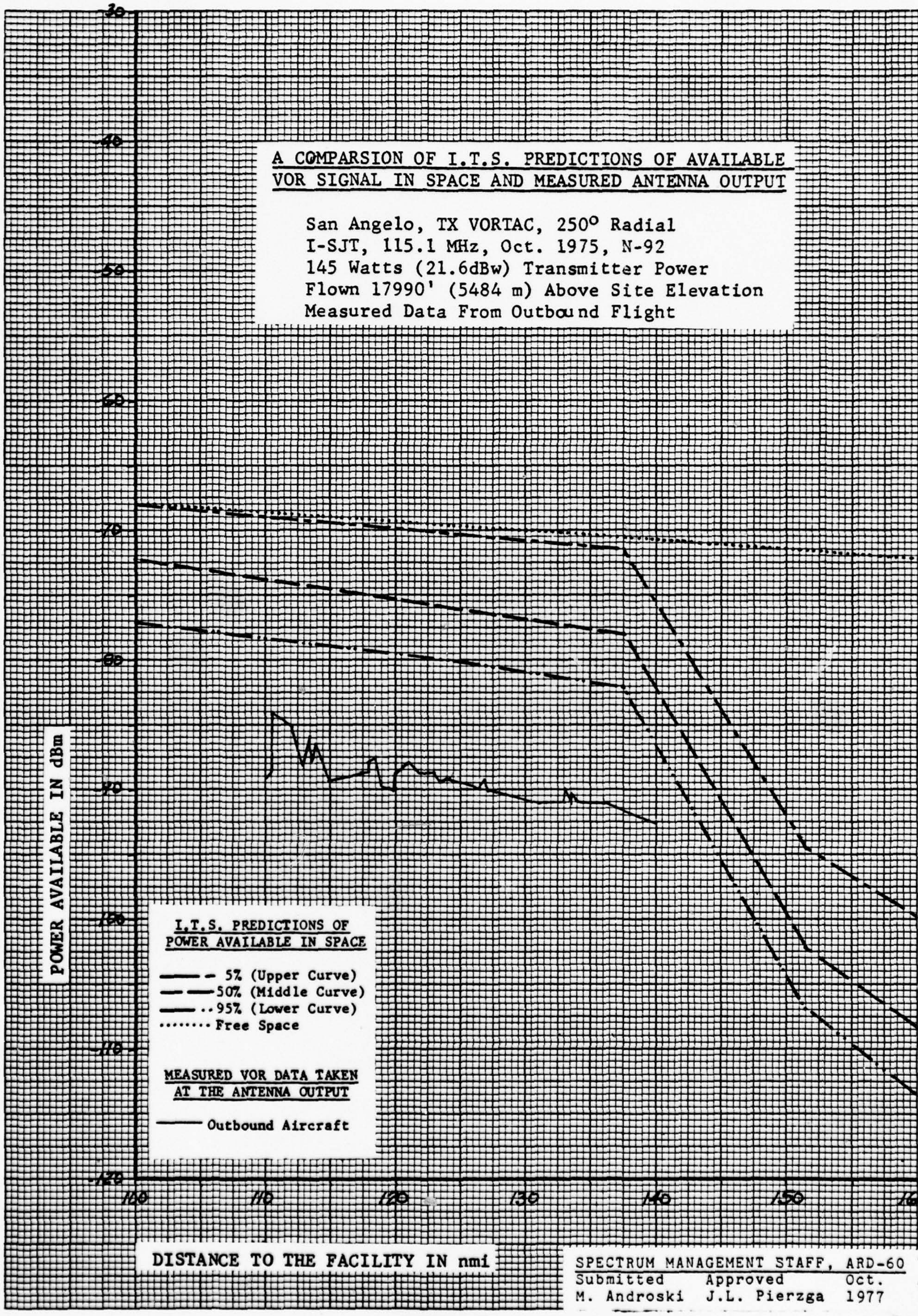


FIGURE G 12

180



A COMPARSION OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
San Angelo, TX VORTAC, 250° Radial
I-SJT, 115.1 MHz, Oct. 1975, N-92
145 Watts (21.6dBw) Transmitter Power
Flown 17990' (5484 m) Above Site Elevation
Measured Data From Outbound Flight
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
POWER AVAILABLE IN dBm
DISTANCE TO THE FACILITY IN nmi
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
100
110
120
130
140
150
160
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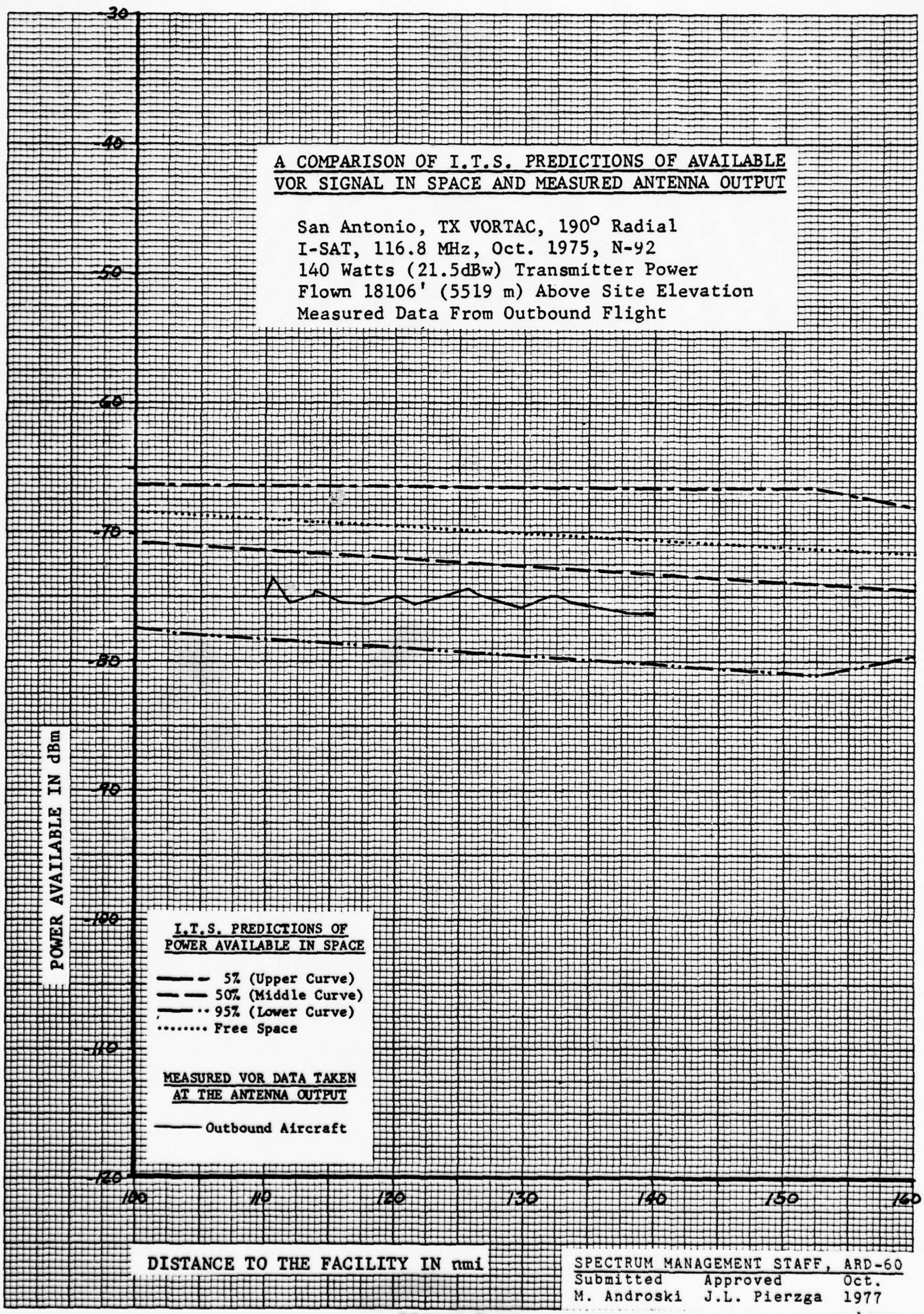
1977

FIGURE G 13



A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE
VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
San Antonio, TX VORTAC, 190° Radial
I-SAT, 116.8 MHz, Oct. 1975, N-92
140 Watts (21.5dBw) Transmitter Power
Flown 18106' (5519 m) Above Site Elevation
Measured Data From Outbound Flight
I.T.S. PREDICTIONS OF
POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN
AT THE ANTENNA OUTPUT
Outbound Aircraft
POWER AVAILABLE IN dBm
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
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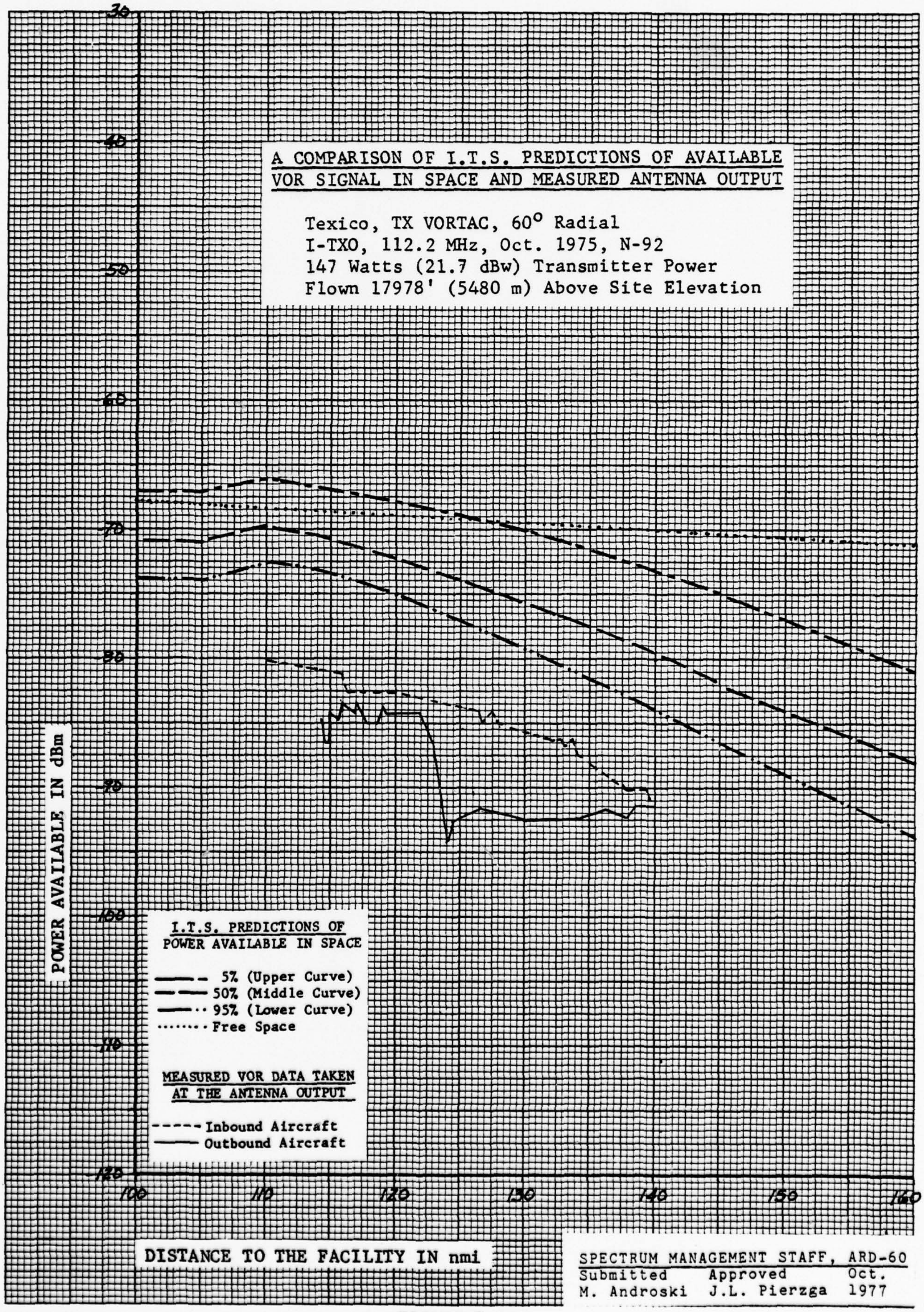
FIGURE G 14



A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Texico, TX VORTAC, 60° Radial
I-TXO, 112.2 MHz, Oct. 1975, N-92
147 Watts (21.7 dBw) Transmitter Power
Flown 17978' (5480 m) Above Site Elevation
POWER AVAILABLE IN dBm
30
40
50
60
70
80
90
100
110
120
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
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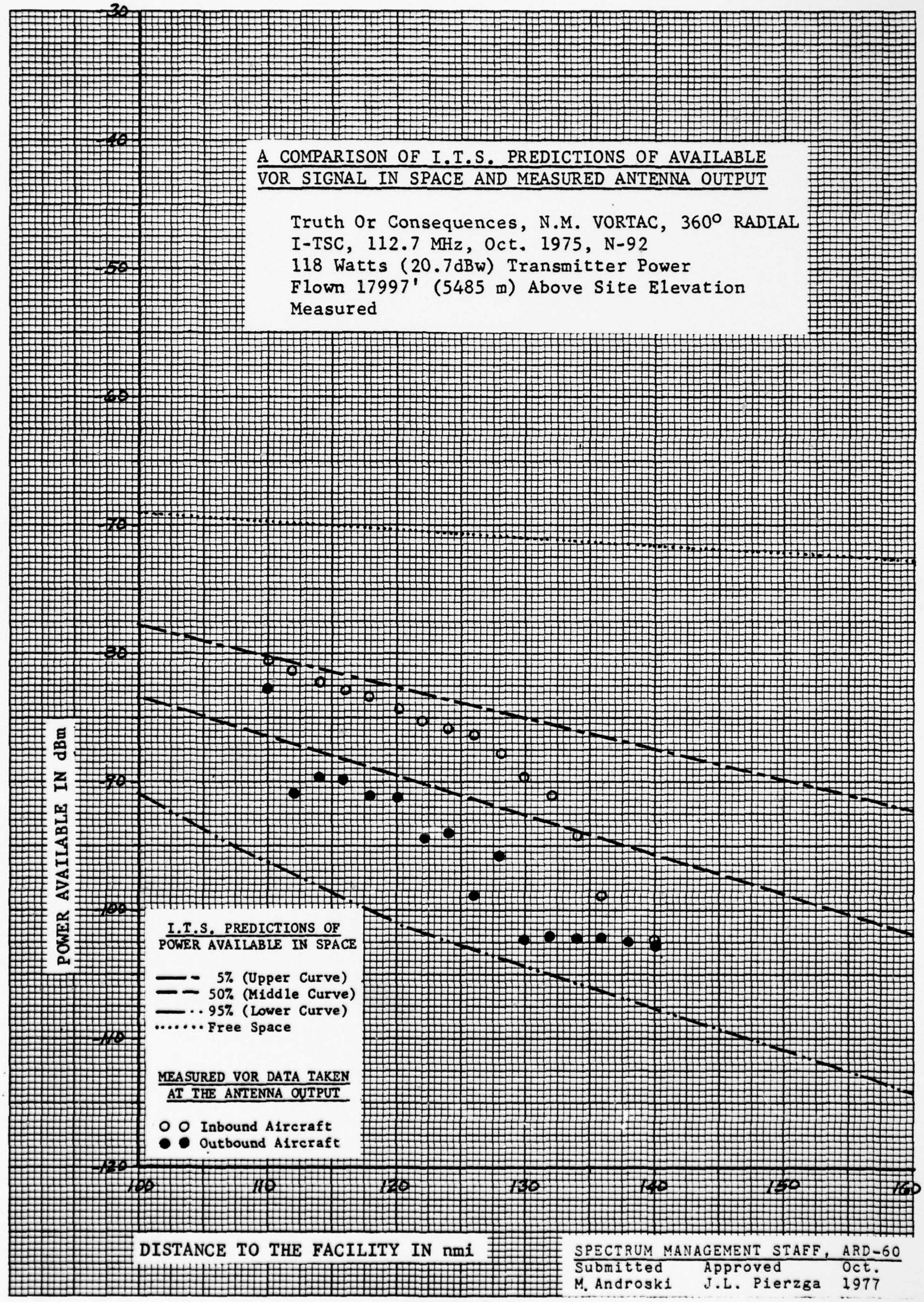
FIGURE G 15



A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE
VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Truth Or Consequences, N.M. VORTAC, 360° RADIAL
I-TSC, 112.7 MHz, Oct. 1975, N-92
118 Watts (20.7dBw) Transmitter Power
Flown 17997' (5485 m) Above Site Elevation
Measured
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF
POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN
AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
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M. Androski
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Oct.
1977

FIGURE G 16

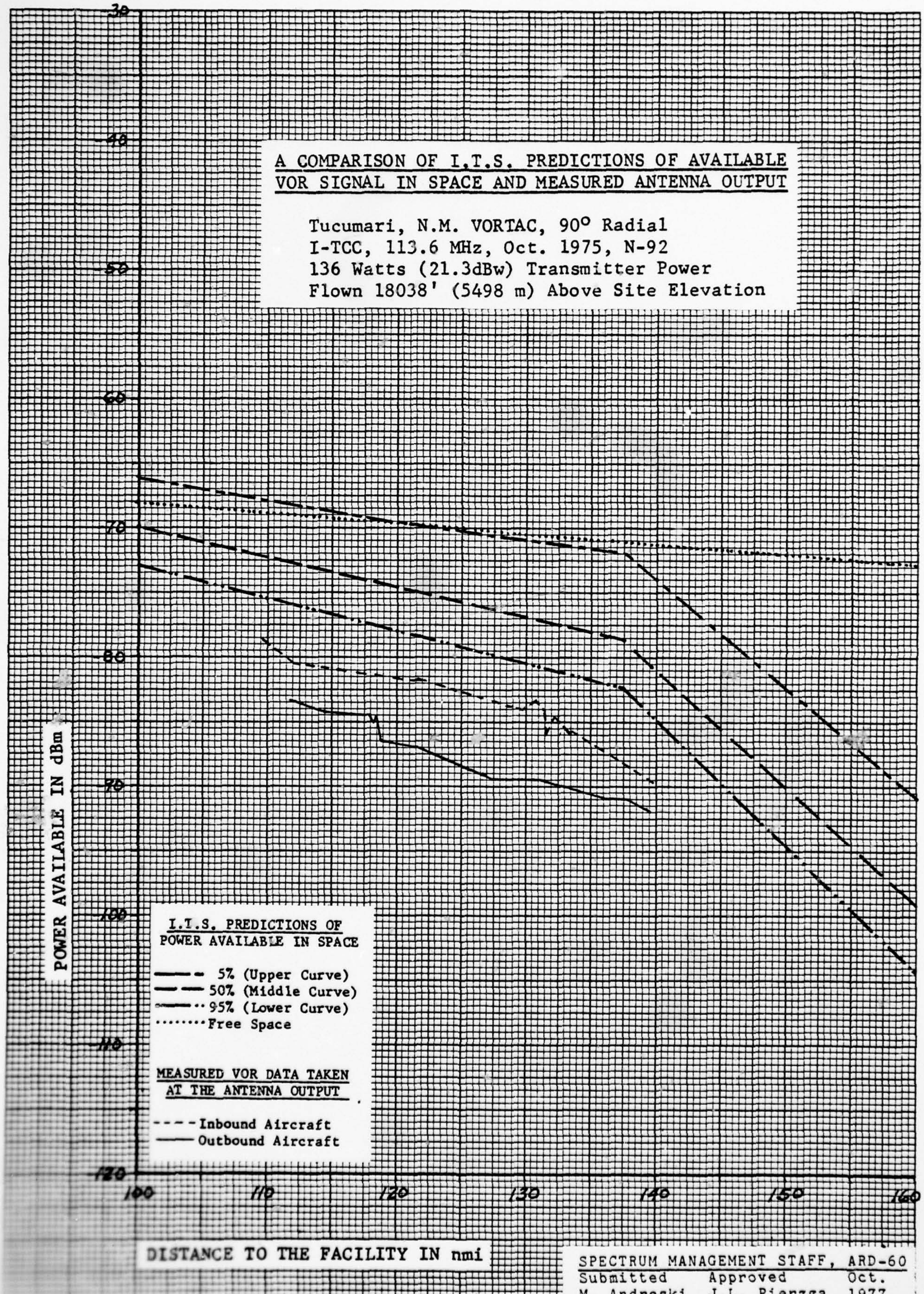

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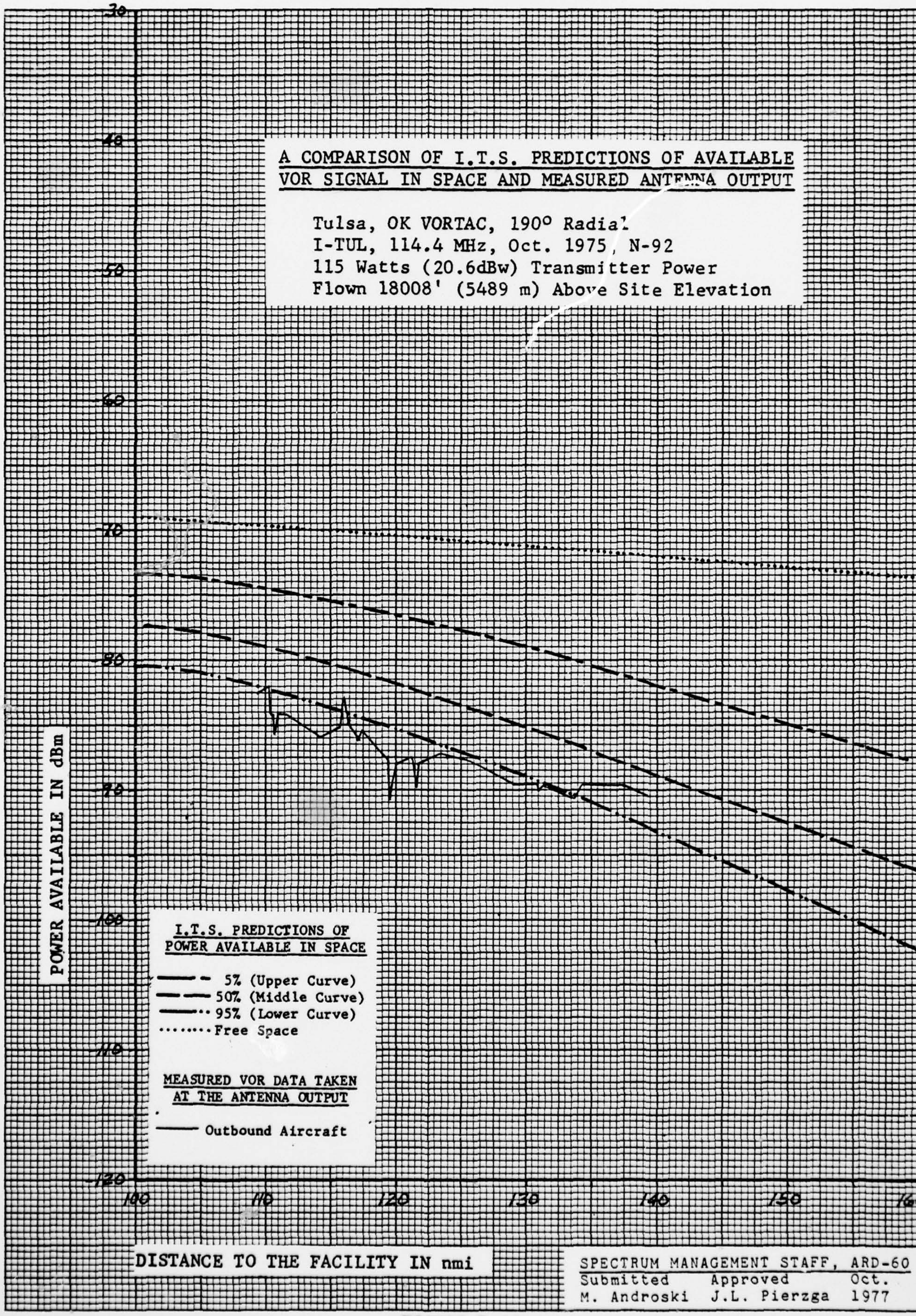
FIGURE G 17



A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Tulsa, OK VORTAC, 190° Radial
I-TUL, 114.4 MHz, Oct. 1975, N-92
115 Watts (20.6dBw) Transmitter Power
Flown 18008' (5489 m) Above Site Elevation
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
SPECTRUM MANAGEMENT STAFF, ARD-60
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FIGURE G 18

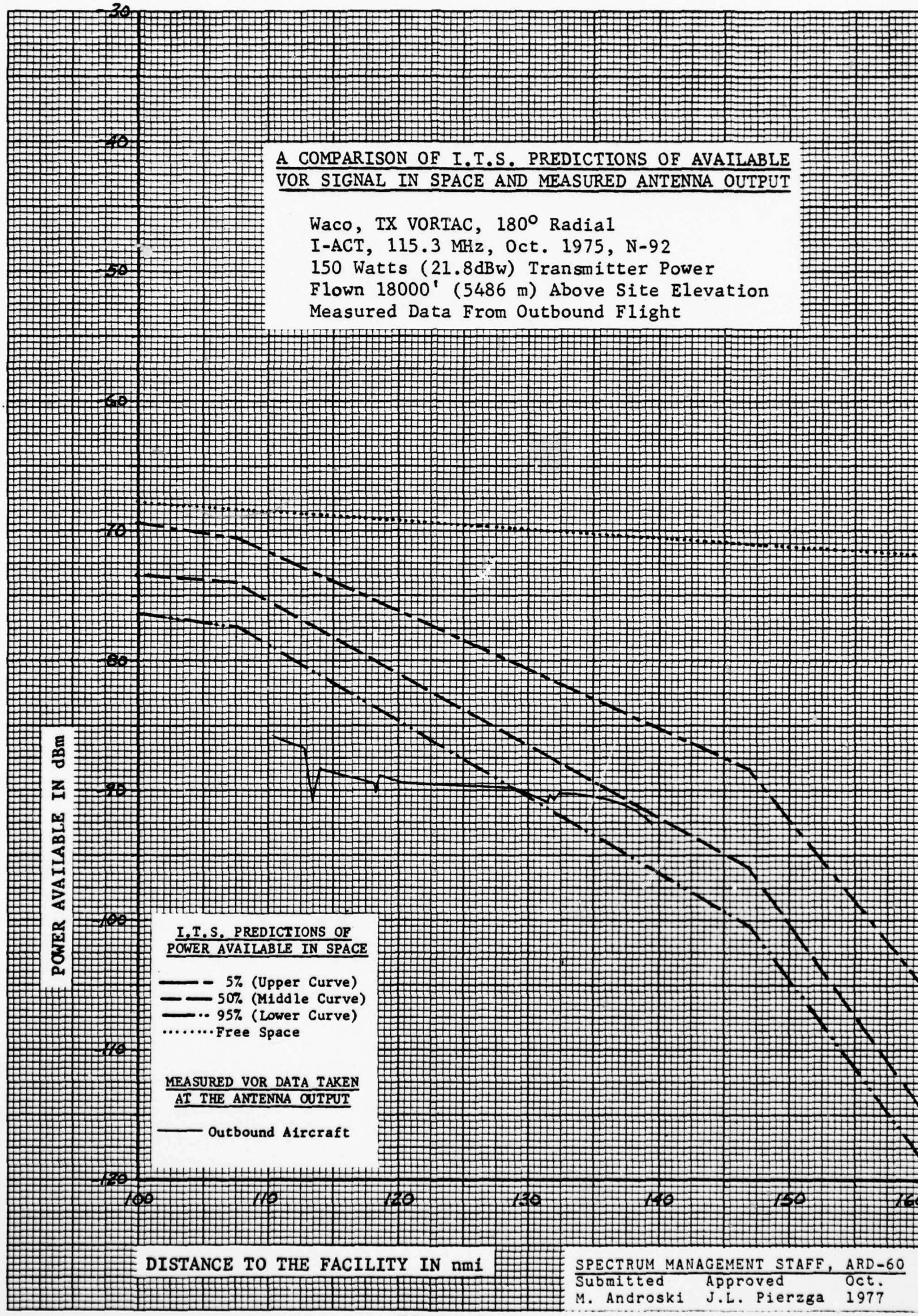
A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE
VOR SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Waco, TX VORTAC, 180° Radial
I-ACT, 115.3 MHz, Oct. 1975, N-92
150 Watts (21.8dBw) Transmitter Power
Flown 18000' (5486 m) Above Site Elevation
Measured Data From Outbound Flight
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED VOR DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
POWER AVAILABLE IN dBm
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
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FIGURE G 19

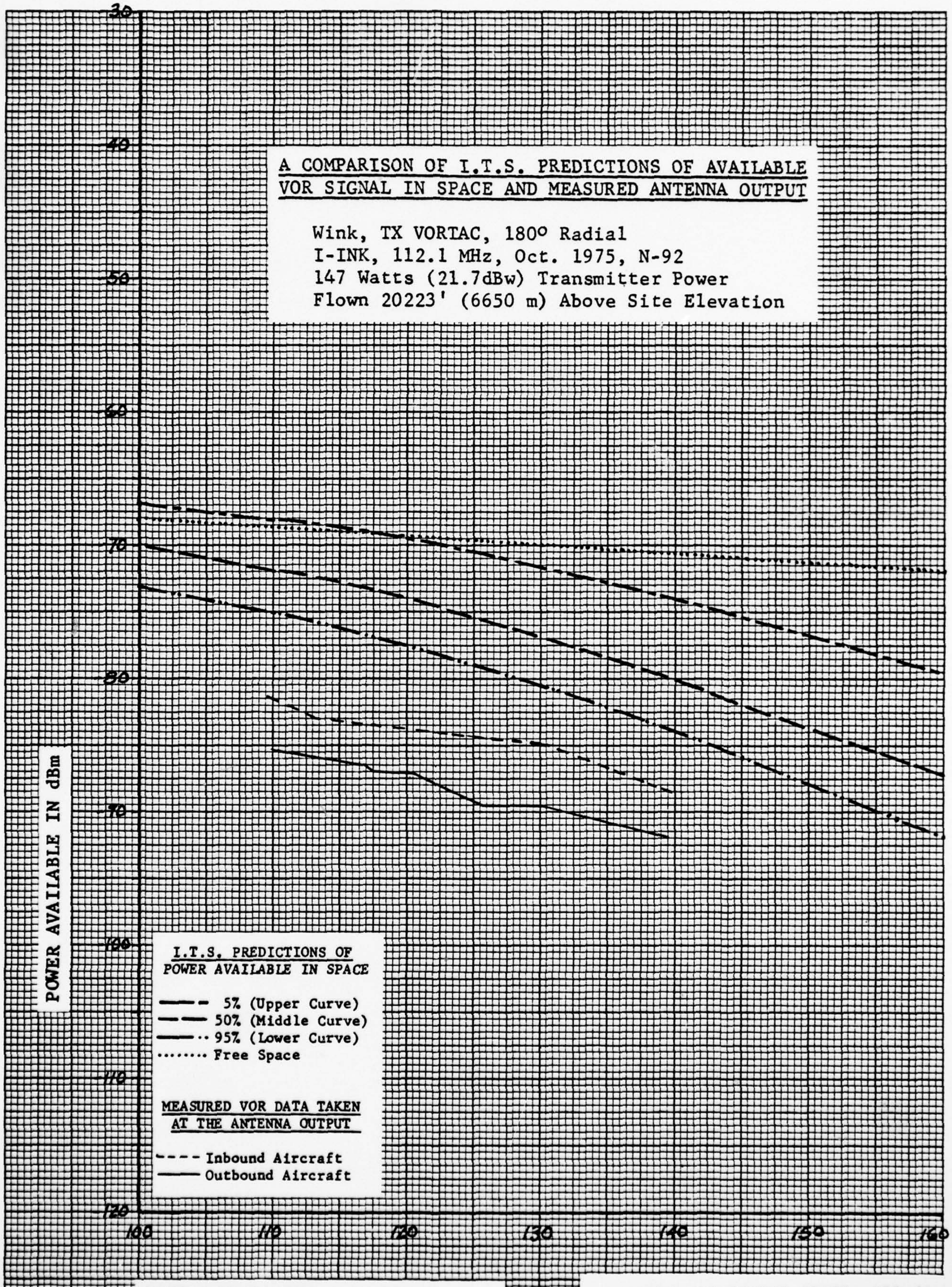

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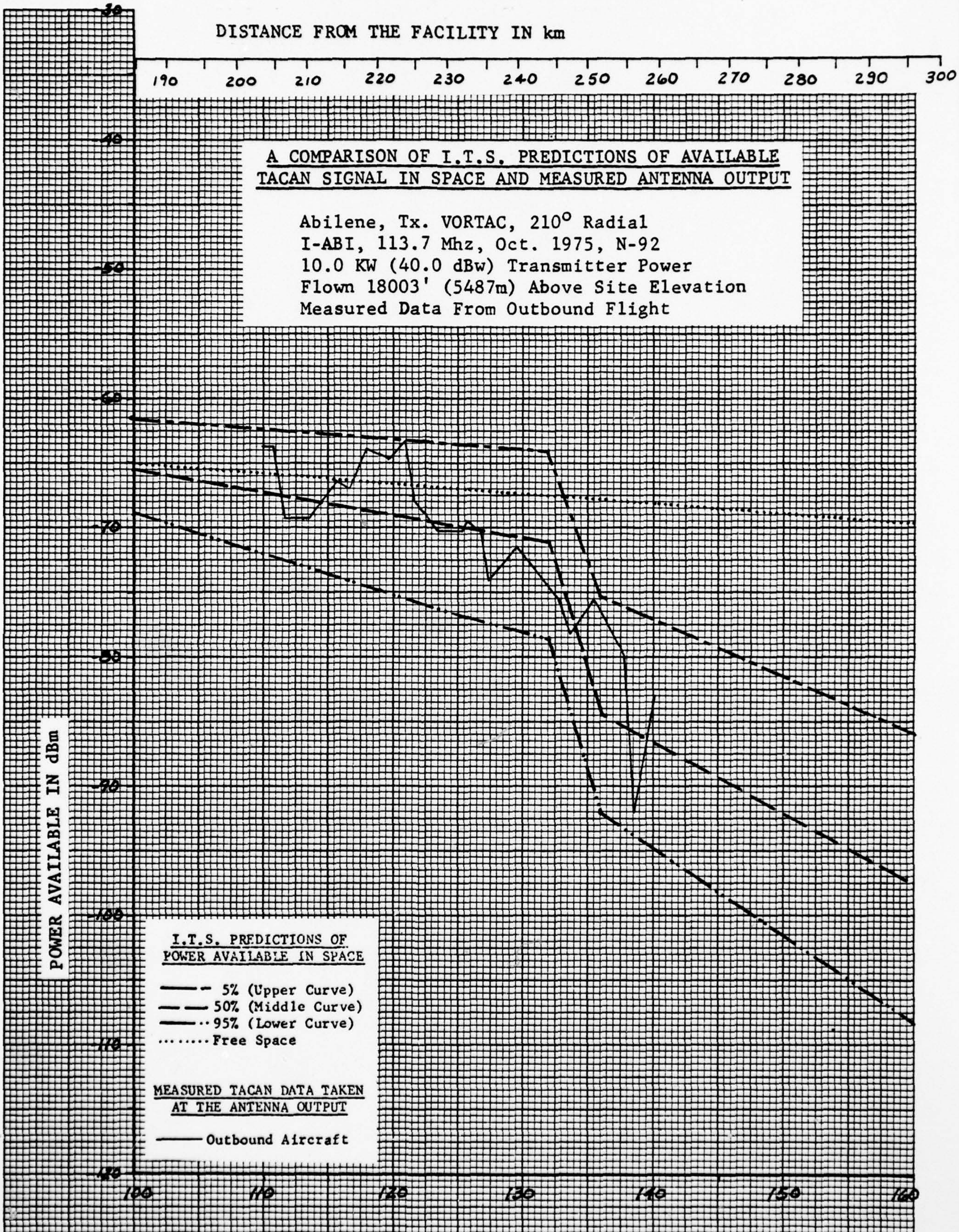
FIGURE G 20

APPENDIX H

COMPARISON OF ITS PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE (CONSIDERING LOCAL TERRAIN) AND MEASURED ANTENNA OUTPUT (PLOTTED IN dBW)

The measured TACAN data shown in this Appendix are identical to the data given in Appendix A. The ITS predictions attempt to take into account the different terrain on the azimuth flown for each VORTAC. Terrain profiles, based on the ECAC terrain files, are shown in Appendix F. These graphs were drawn by a computer model which also provides a digital printout of the data. A summary of the digital outputs of the horizon parameters is shown in Table F-1, page F-42. These values were used as inputs parameters for the ITS/FAA model. The resulting model outputs are shown in Appendix I.



SPECTRUM MANAGEMENT STAFF, ARD-60

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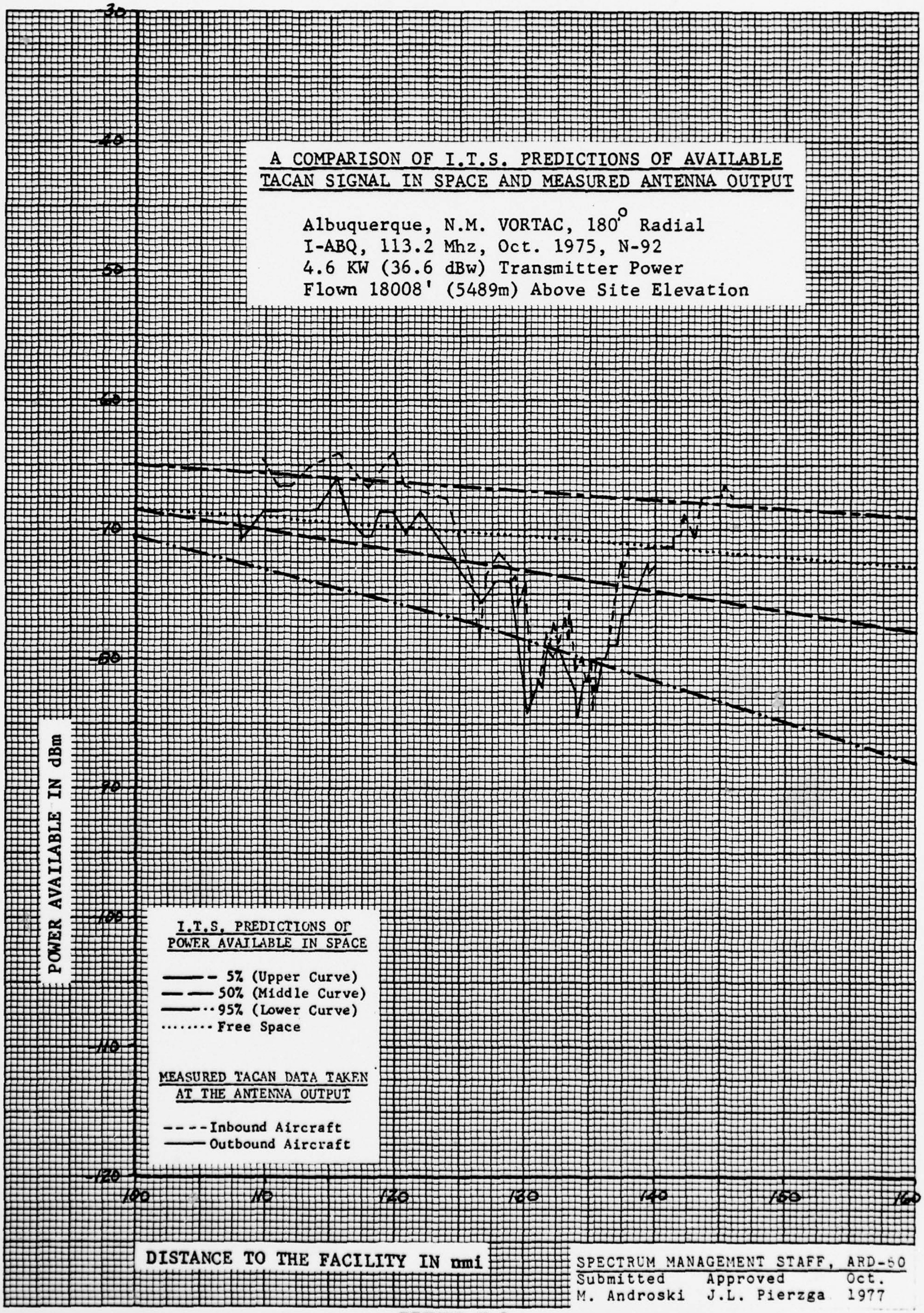
M. Androski	J.L. Pierzga	1977

FIGURE H 1



A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Albuquerque, N.M. VORTAC, 180° Radial
I-ABQ, 113.2 Mhz, Oct. 1975, N-92
4.6 KW (36.6 dBw) Transmitter Power
Flown 18008' (5489m) Above Site Elevation
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved Oct.
M. Androski J.L. Pierzga 1977

FIGURE H 2

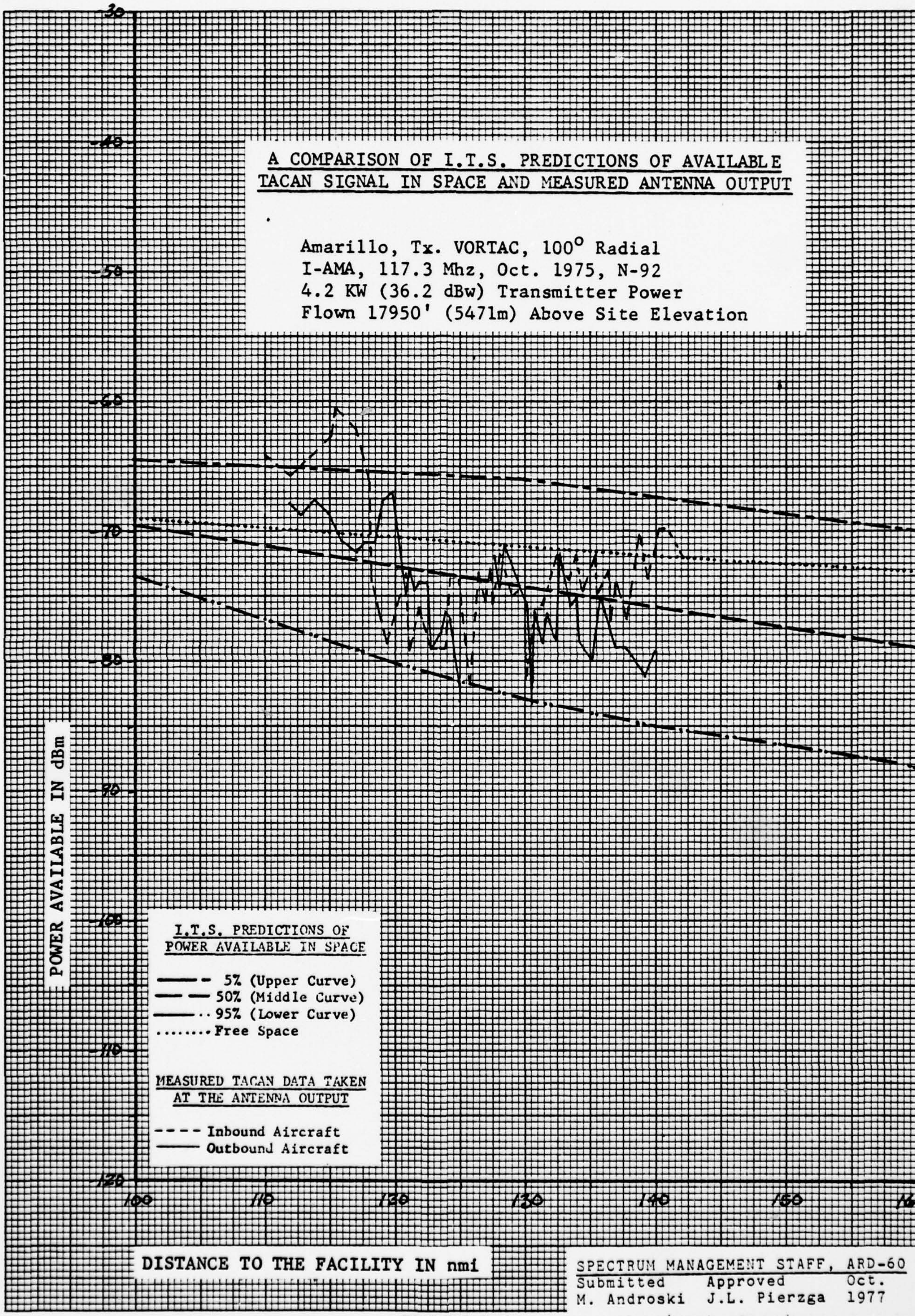


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FIGURE H 3

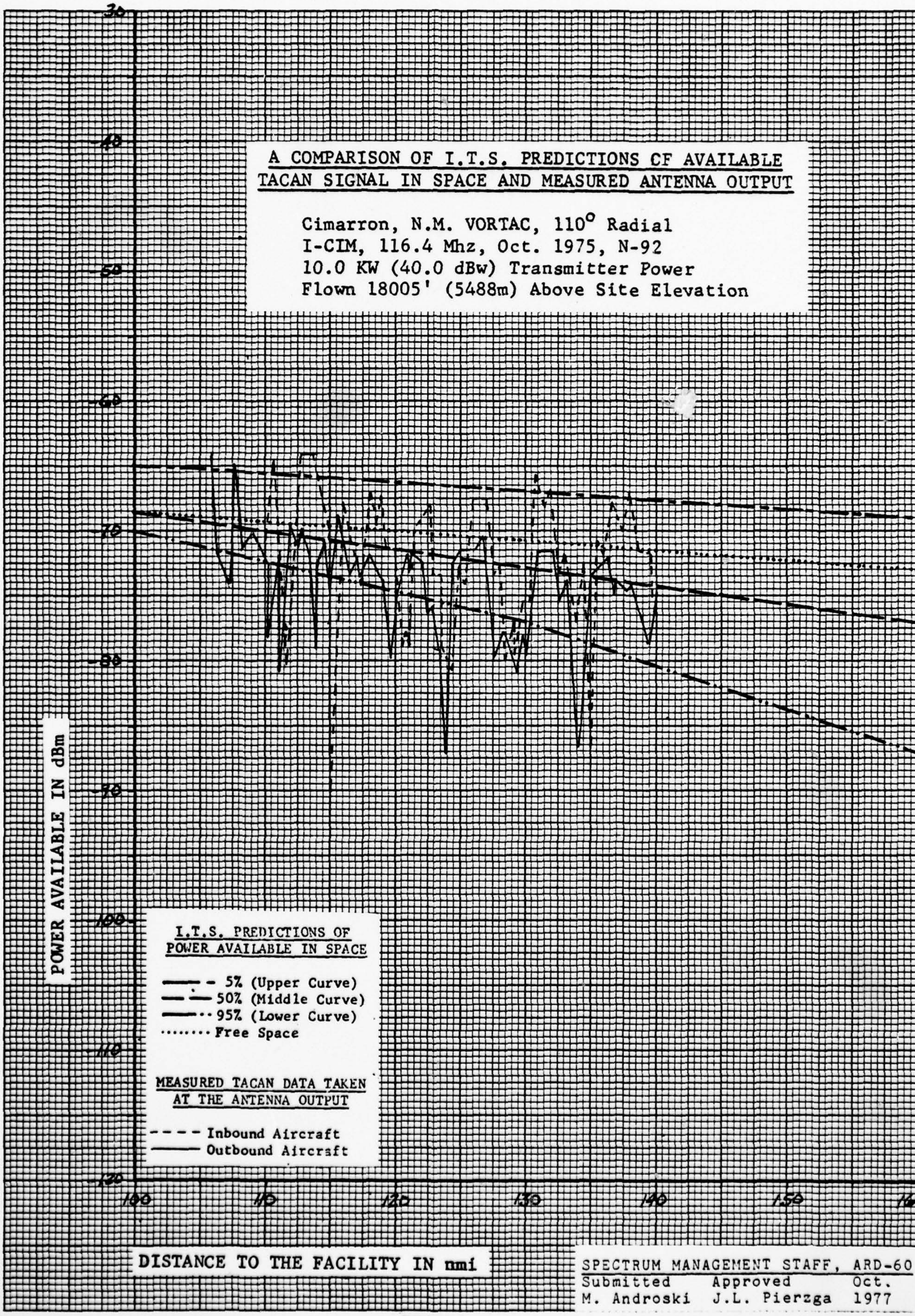
A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Cimarron, N.M. VORTAC, 110° Radial
I-CIM, 116.4 Mhz, Oct. 1975, N-92
10.0 KW (40.0 dBw) Transmitter Power
Flown 18005' (5488m) Above Site Elevation
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
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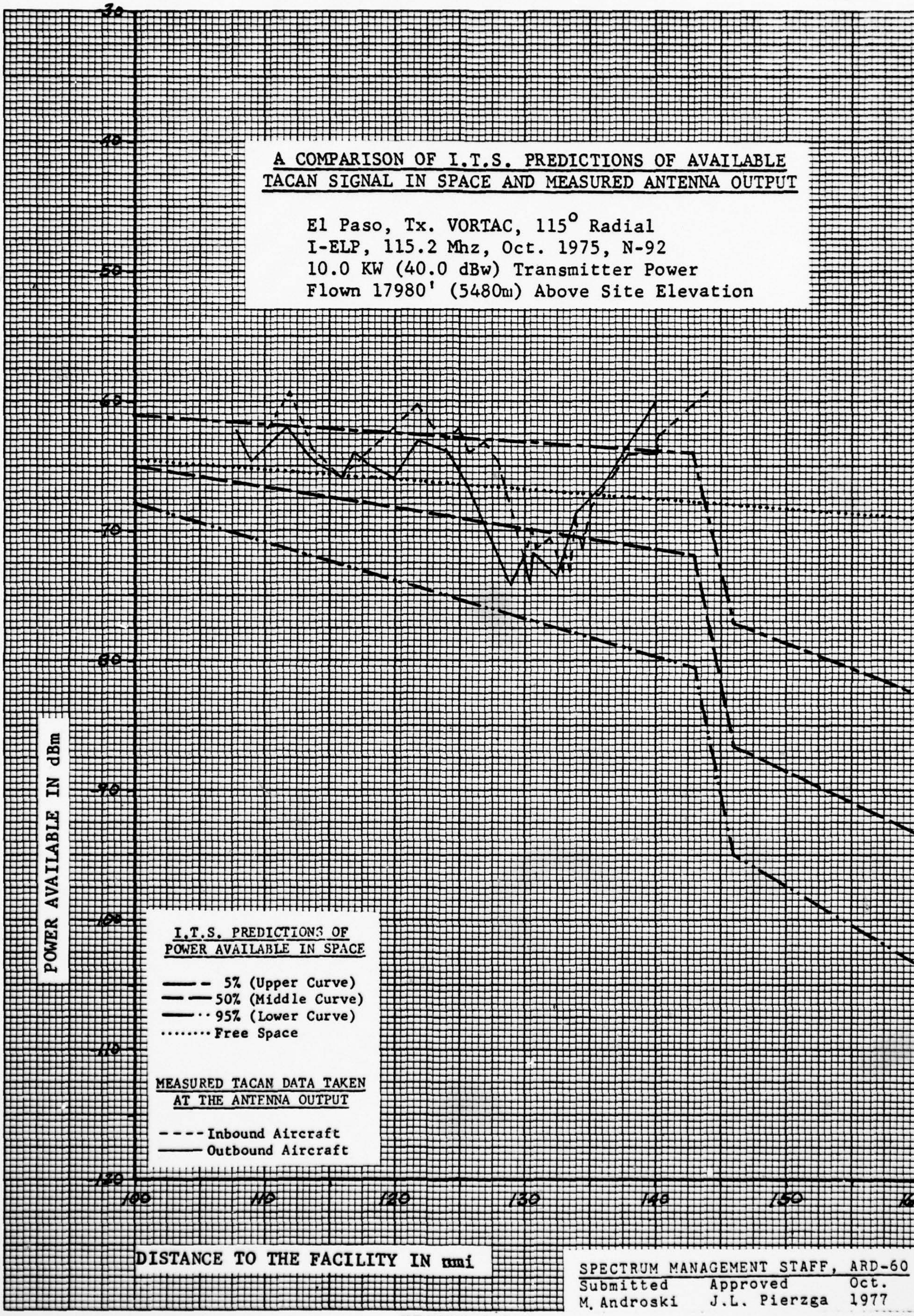
FIGURE H 4


A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE
TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
El Paso, Tx. VORTAC, 115° Radial
I-ELP, 115.2 Mhz, Oct. 1975, N-92
10.0 KW (40.0 dBw) Transmitter Power
Flown 17980' (5480m) Above Site Elevation
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
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Oct.
1977

FIGURE H 5

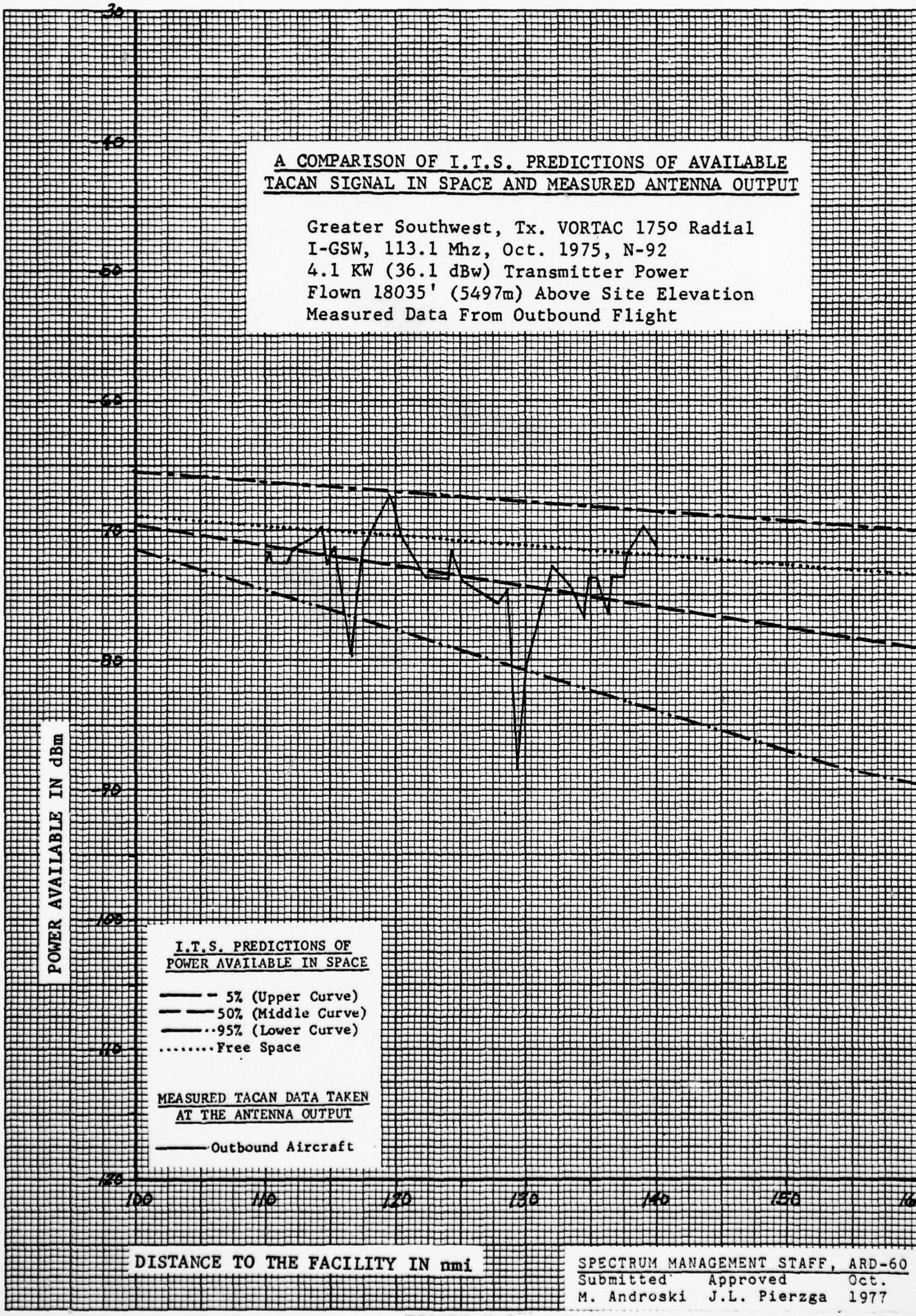
A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Greater Southwest, Tx. VORTAC 175° Radial
I-GSW, 113.1 Mhz, Oct. 1975, N-92
4.1 KW (36.1 dBw) Transmitter Power
Flown 18035' (5497m) Above Site Elevation
Measured Data From Outbound Flight
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
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FIGURE H 6

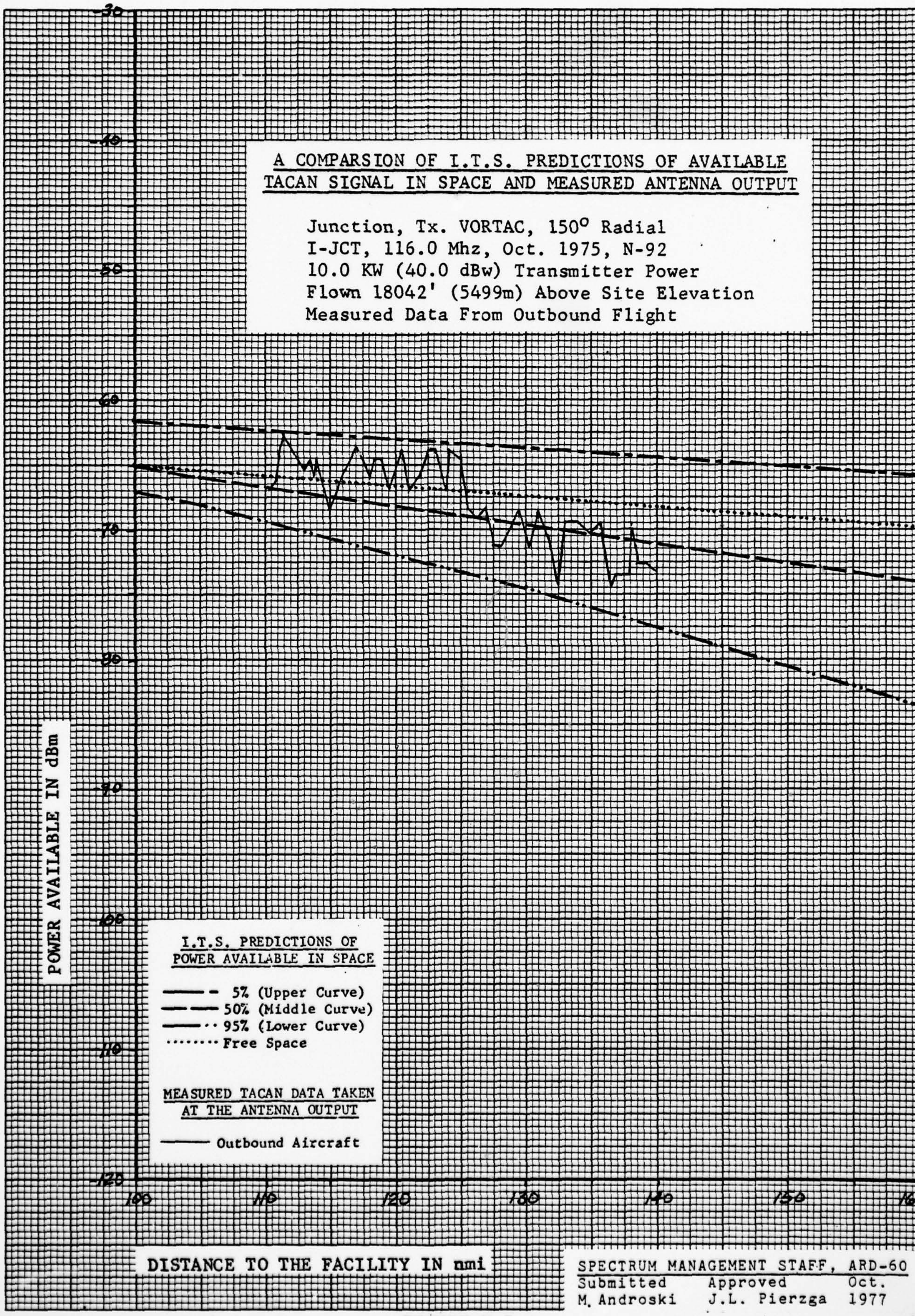
A COMPARSION OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Junction, Tx. VORTAC, 150° Radial
I-JCT, 116.0 Mhz, Oct. 1975, N-92
10.0 KW (40.0 dBw) Transmitter Power
Flown 18042' (5499m) Above Site Elevation
Measured Data From Outbound Flight
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted M. Androski
Approved J.L. Pierzga
Oct. 1977

FIGURE H 7

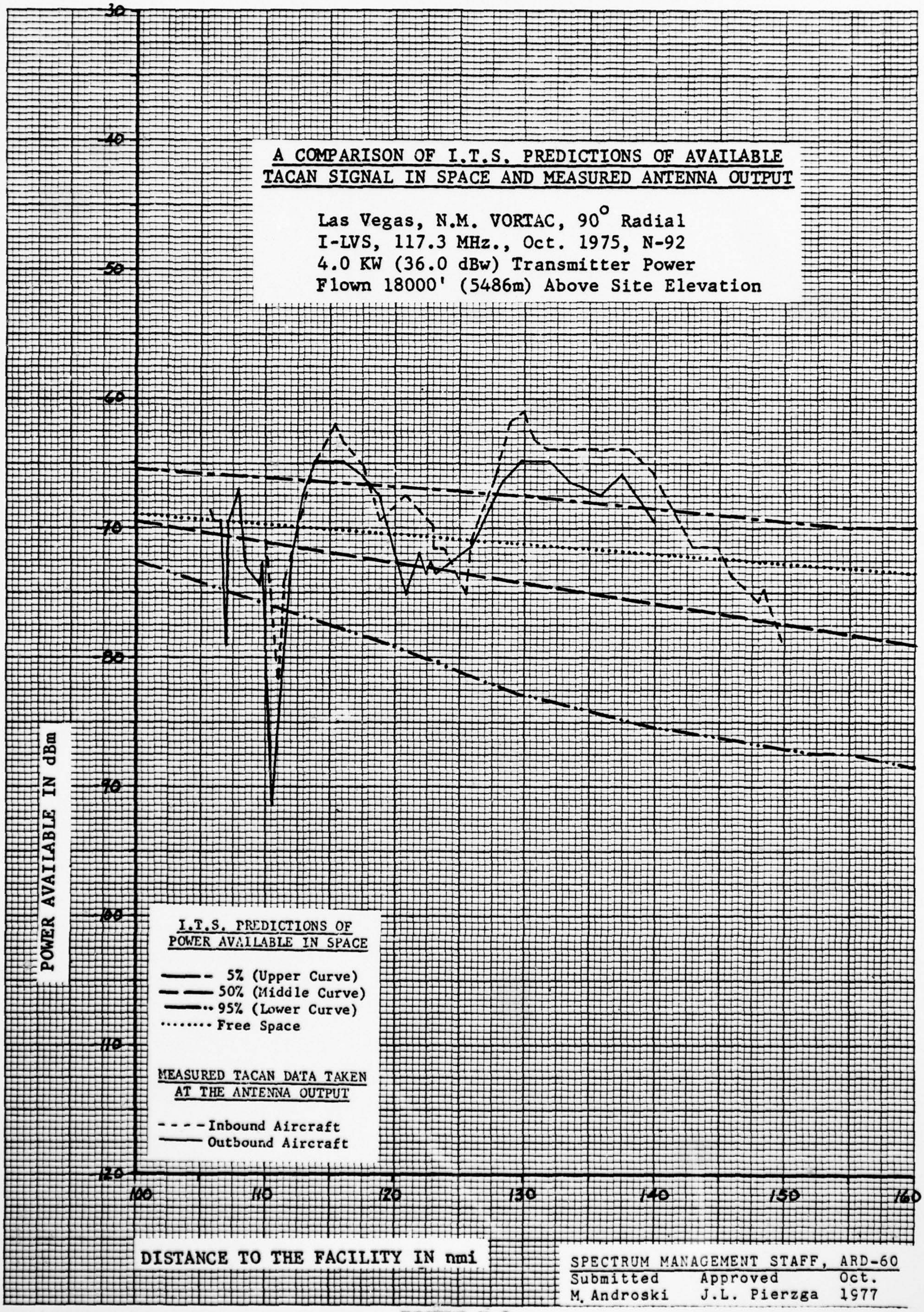
A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Las Vegas, N.M. VORTAC, 90° Radial
I-LVS, 117.3 MHz., Oct. 1975, N-92
4.0 KW (36.0 dBw) Transmitter Power
Flown 18000' (5486m) Above Site Elevation
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
POWER AVAILABLE IN dBm
30
40
50
60
70
80
90
100
110
120
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted
M. Androski
Approved
J.L. Pierzga
Oct.
1977

FIGURE H 8

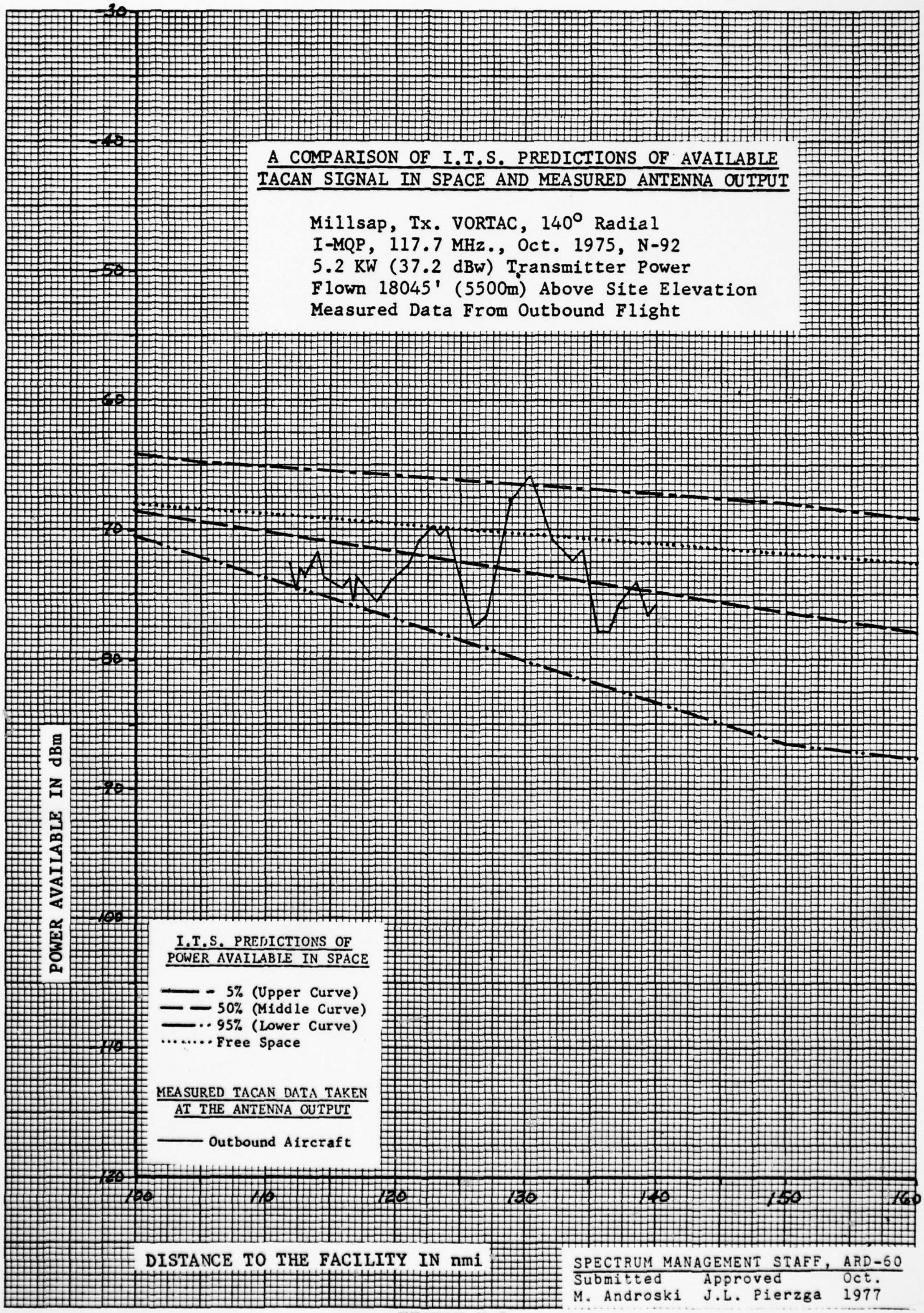
A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Millsap, Tx. VORTAC, 140° Radial
I-MQP, 117.7 MHz., Oct. 1975, N-92
5.2 KW (37.2 dBw) Transmitter Power
Flown 18045' (5500m) Above Site Elevation
Measured Data From Outbound Flight
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved Oct.
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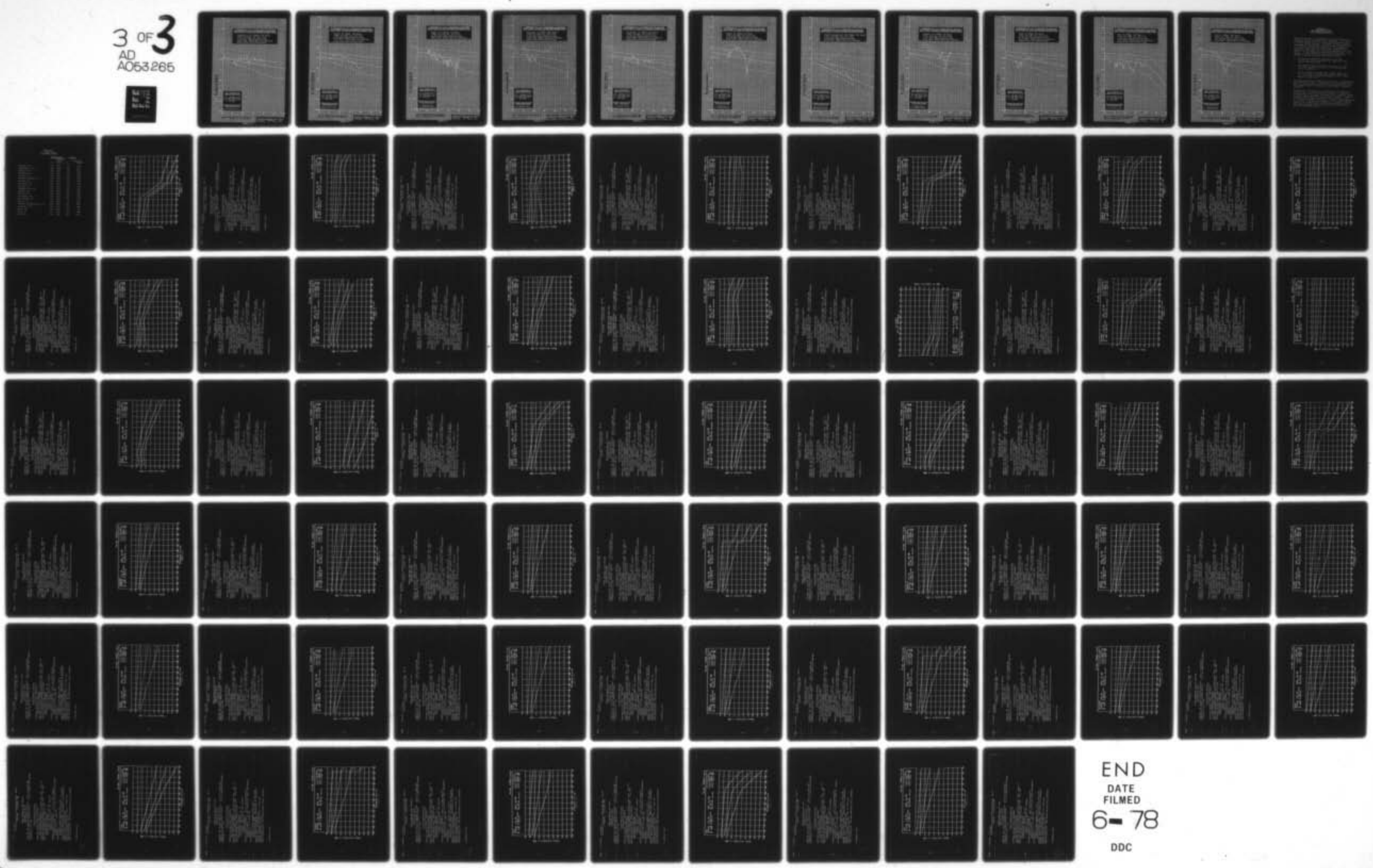
FIGURE H 9

AD-A053 265 FEDERAL AVIATION ADMINISTRATION WASHINGTON D C SYSTE--ETC F/G 17/7
A COMPARISON OF MEASURED DATA AND ITS MODEL PREDICTIONS.(U)
JAN 78 R D SMITH
UNCLASSIFIED FAA-RD-77-106 NL

3 OF 3
AD
A053265



END
DATE
FILMED
6-78
DDC

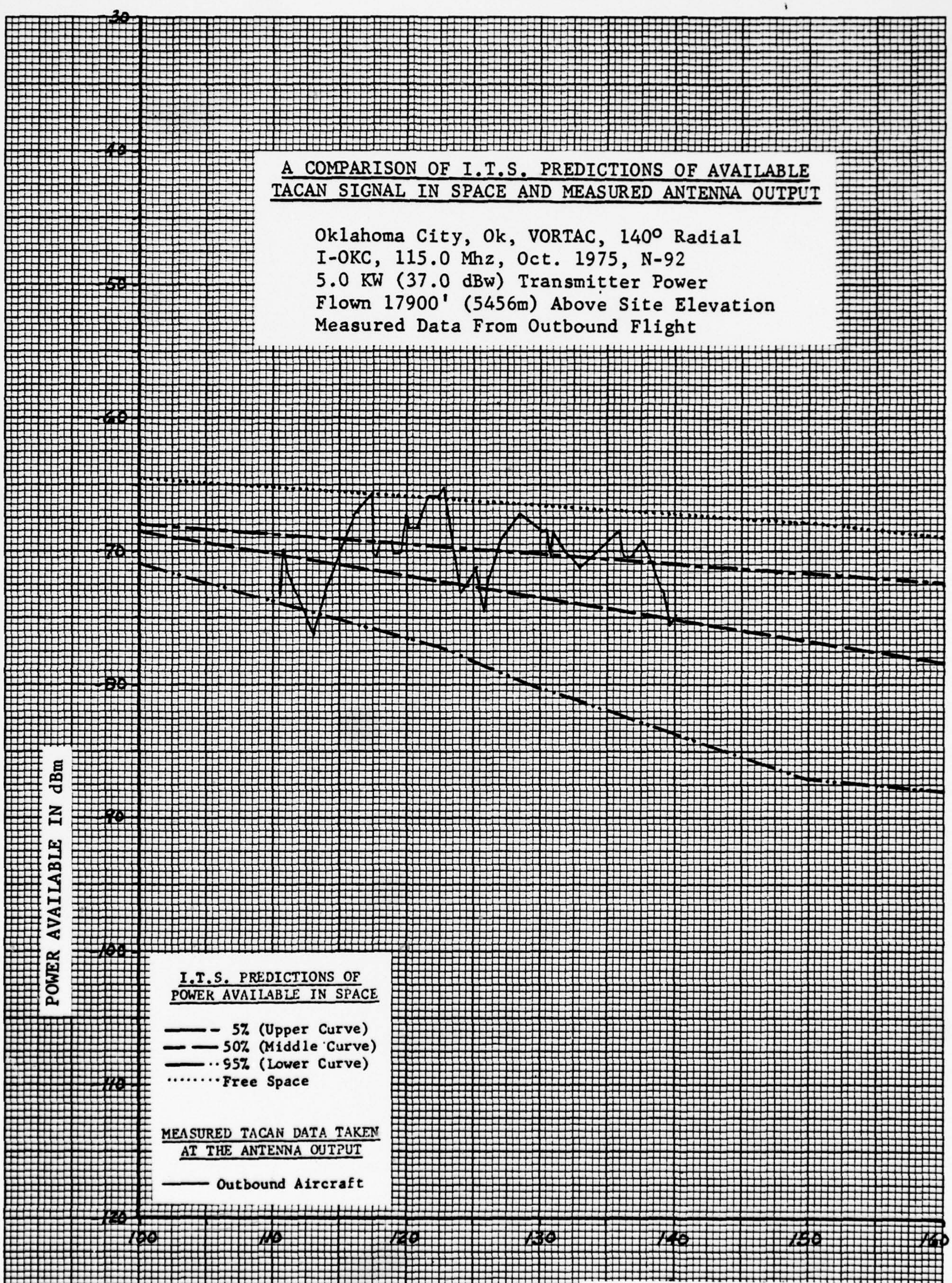


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FIGURE H 10

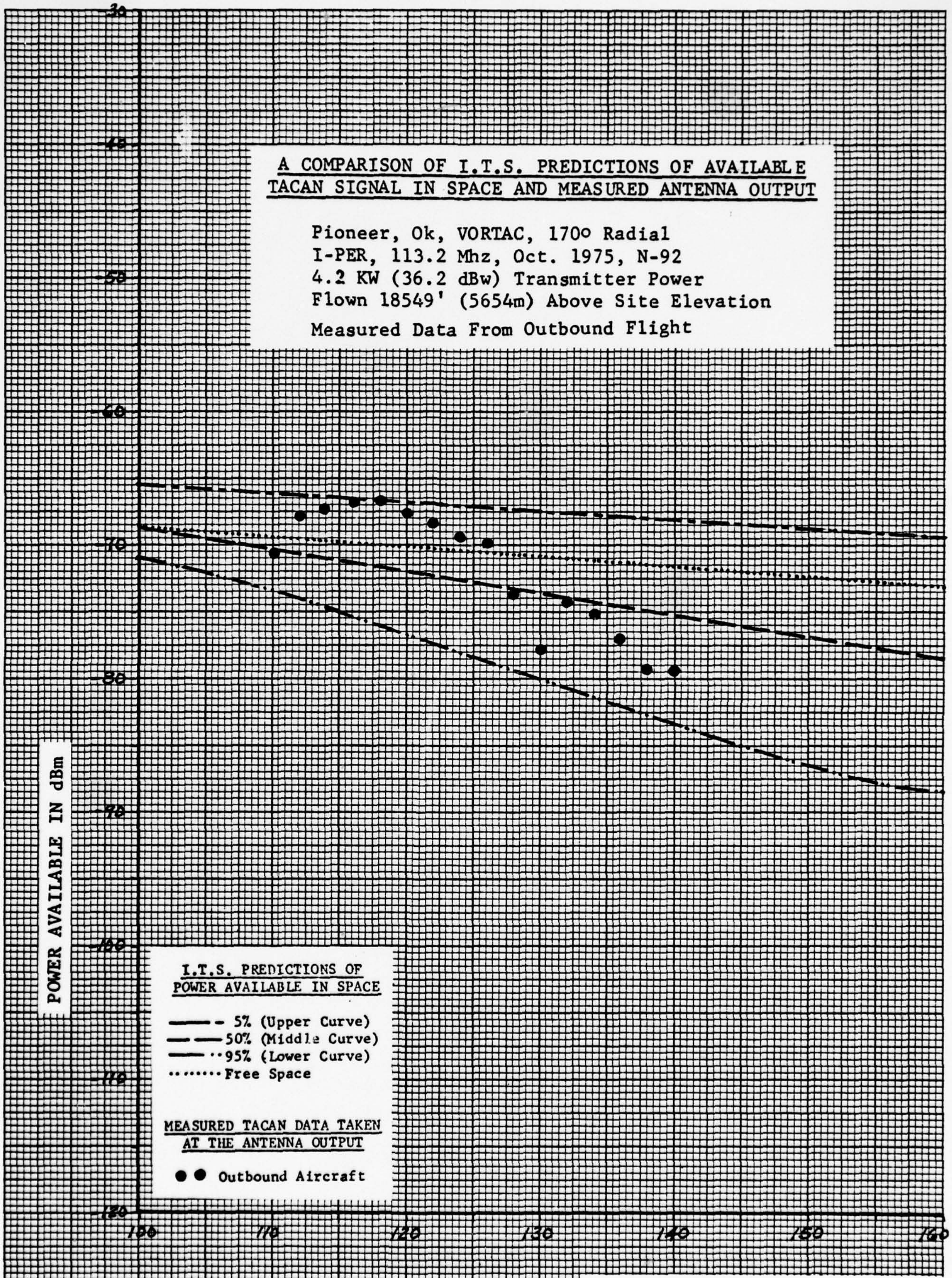

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FIGURE H 11

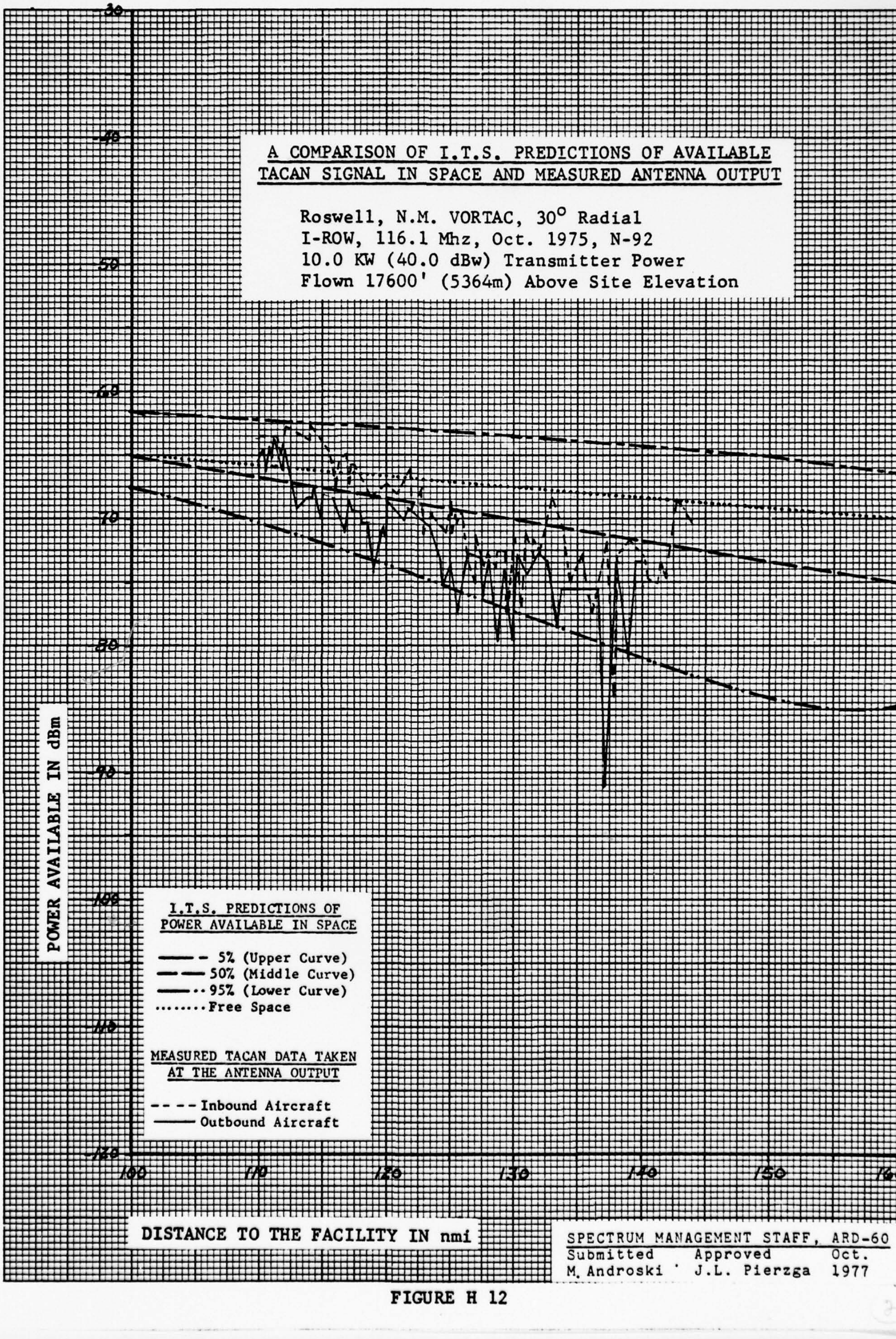
A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Roswell, N.M. VORTAC, 30° Radial
I-ROW, 116.1 Mhz, Oct. 1975, N-92
10.0 KW (40.0 dBw) Transmitter Power
Flown 17600' (5364m) Above Site Elevation
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
POWER AVAILABLE IN dBm
DISTANCE TO THE FACILITY IN nmi
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
100
110
120
130
140
150
160
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted M. Androski
Approved J.L. Pierzga
Oct. 1977

FIGURE H 12

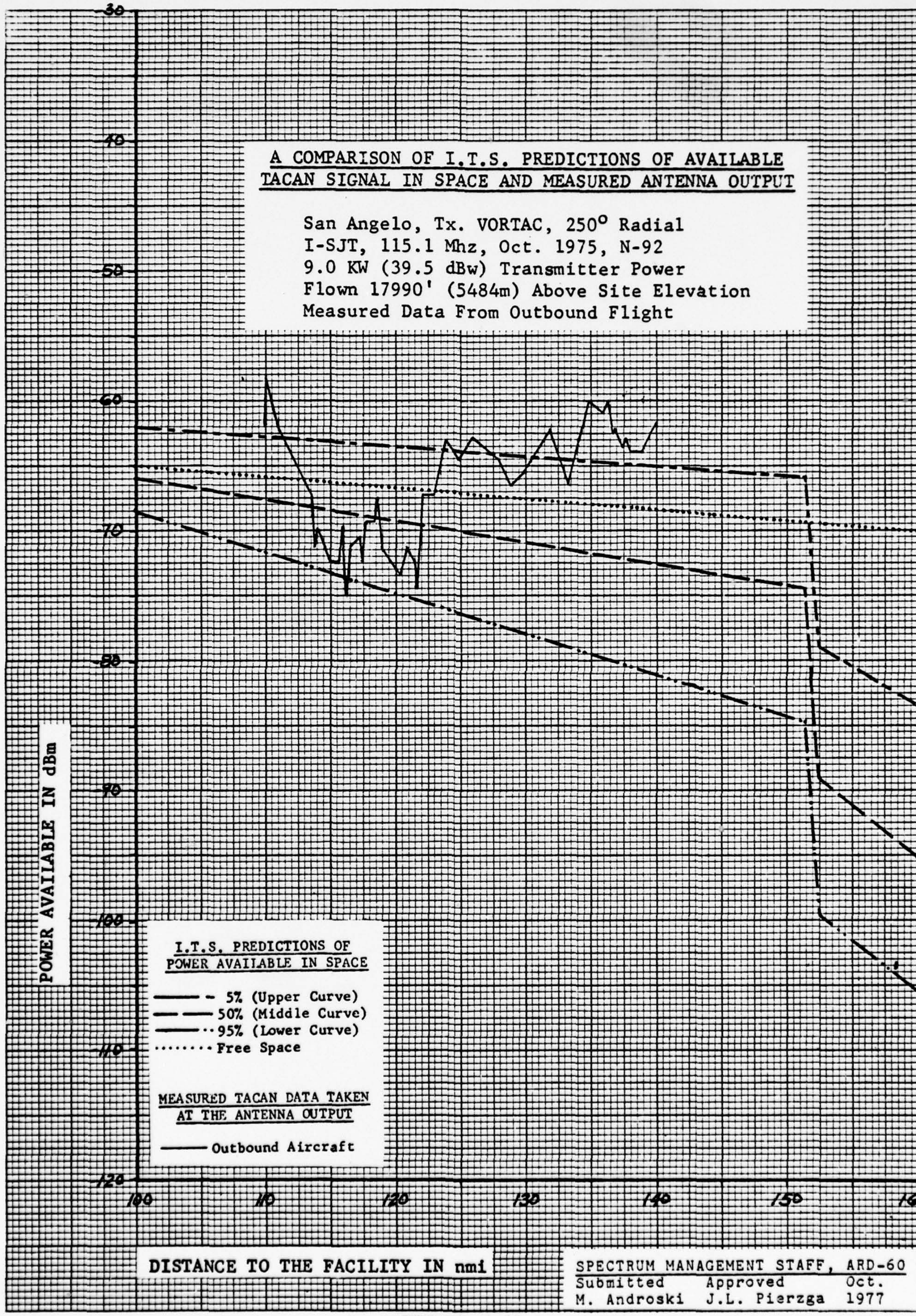
A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
San Angelo, Tx. VORTAC, 250° Radial
I-SJT, 115.1 Mhz, Oct. 1975, N-92
9.0 KW (39.5 dBw) Transmitter Power
Flown 17990' (5484m) Above Site Elevation
Measured Data From Outbound Flight
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
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FIGURE H 13

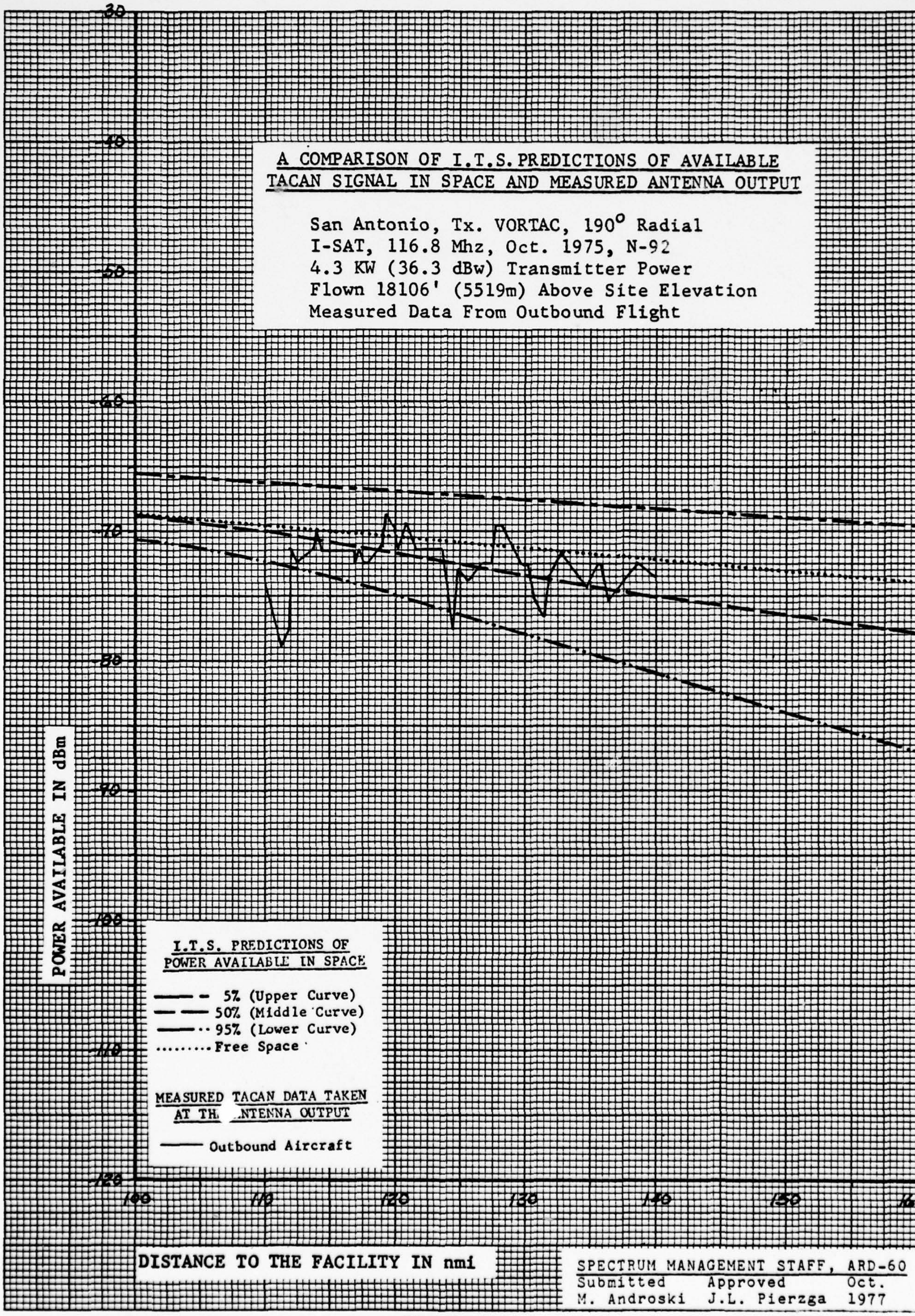
A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
San Antonio, Tx. VORTAC, 190° Radial
I-SAT, 116.8 Mhz, Oct. 1975, N-92
4.3 KW (36.3 dBw) Transmitter Power
Flown 18106' (5519m) Above Site Elevation
Measured Data From Outbound Flight
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
POWER AVAILABLE IN dBm
30
40
50
60
70
80
90
100
110
120
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved Oct.
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FIGURE H 14

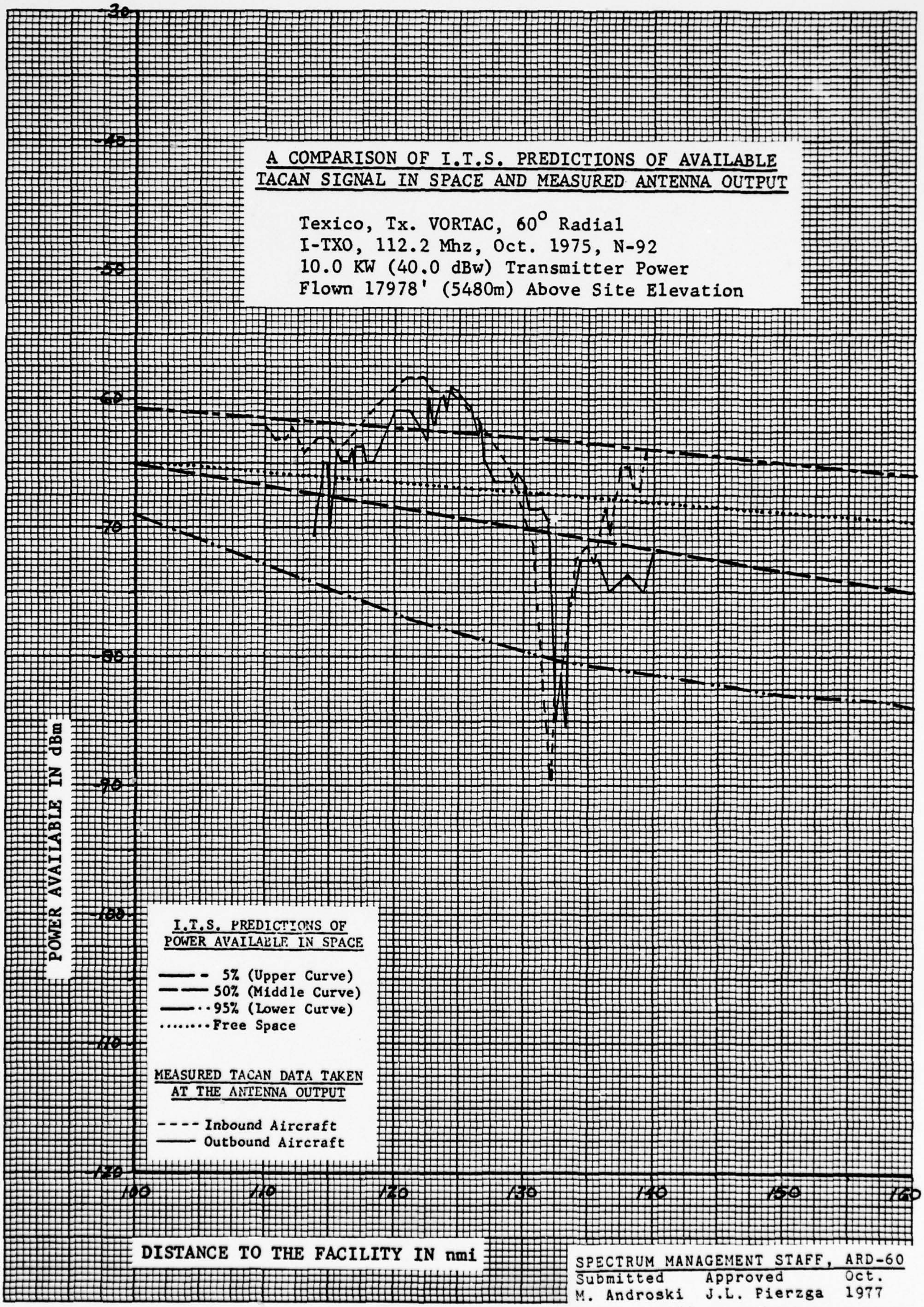
A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Texico, Tx. VORTAC, 60° Radial
I-TXO, 112.2 Mhz, Oct. 1975, N-92
10.0 KW (40.0 dBw) Transmitter Power
Flown 17978' (5480m) Above Site Elevation
POWER AVAILABLE IN dBm
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted M. Androski
Approved J.L. Pierzga
Oct. 1977

FIGURE H 15

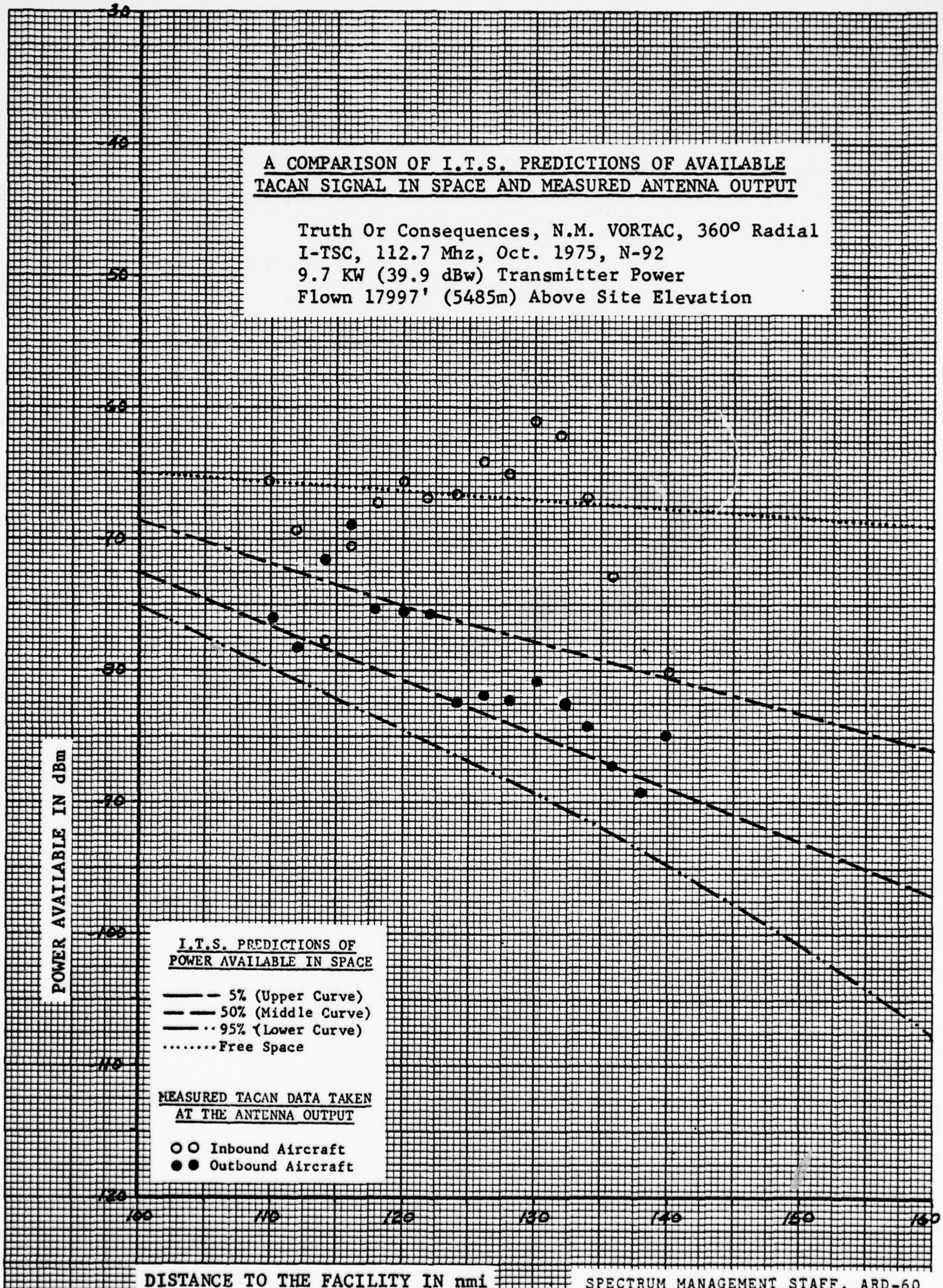

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FIGURE H 16

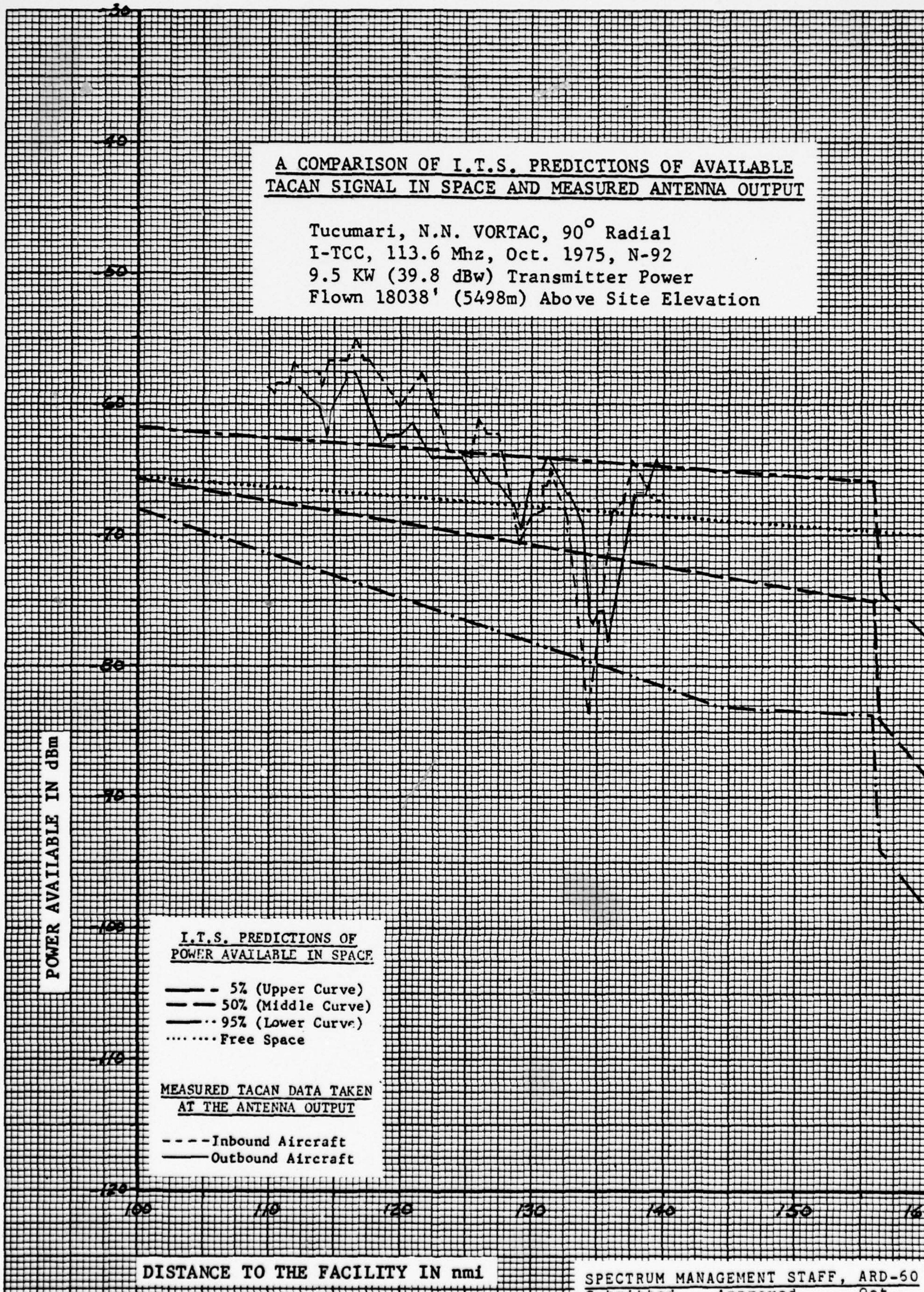
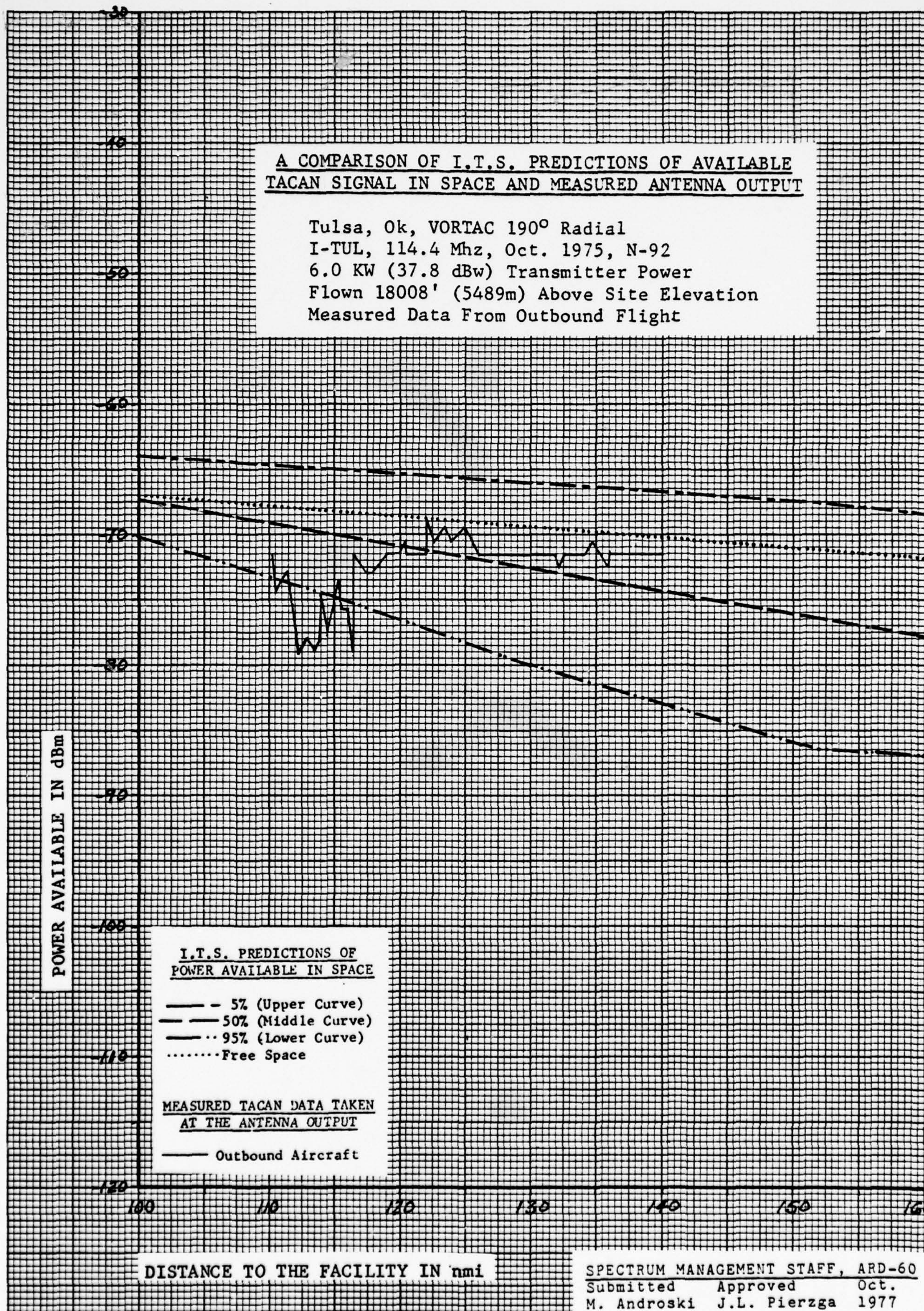

A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Tucumari, N.N. VORTAC, 90° Radial
I-TCC, 113.6 Mhz, Oct. 1975, N-92
9.5 KW (39.8 dBw) Transmitter Power
Flown 18038' (5498m) Above Site Elevation
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved Oct.
M. Androski J.L. Pierzga 1977

FIGURE H 17



A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Tulsa, Ok, VORTAC 190° Radial
I-TUL, 114.4 Mhz, Oct. 1975, N-92
6.0 KW (37.8 dBw) Transmitter Power
Flown 18008' (5489m) Above Site Elevation
Measured Data From Outbound Flight
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
POWER AVAILABLE IN dBm
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted Approved Oct.
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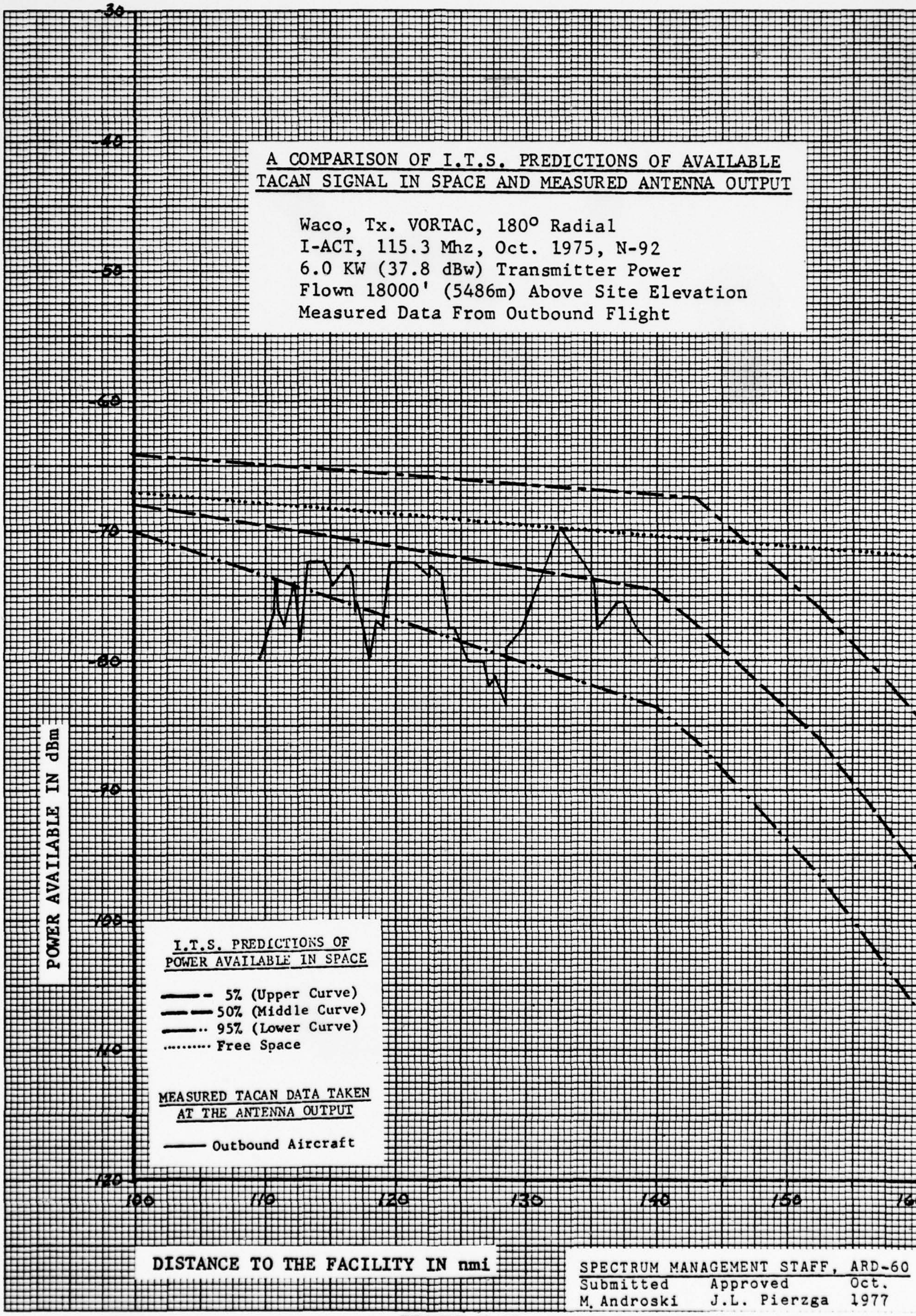
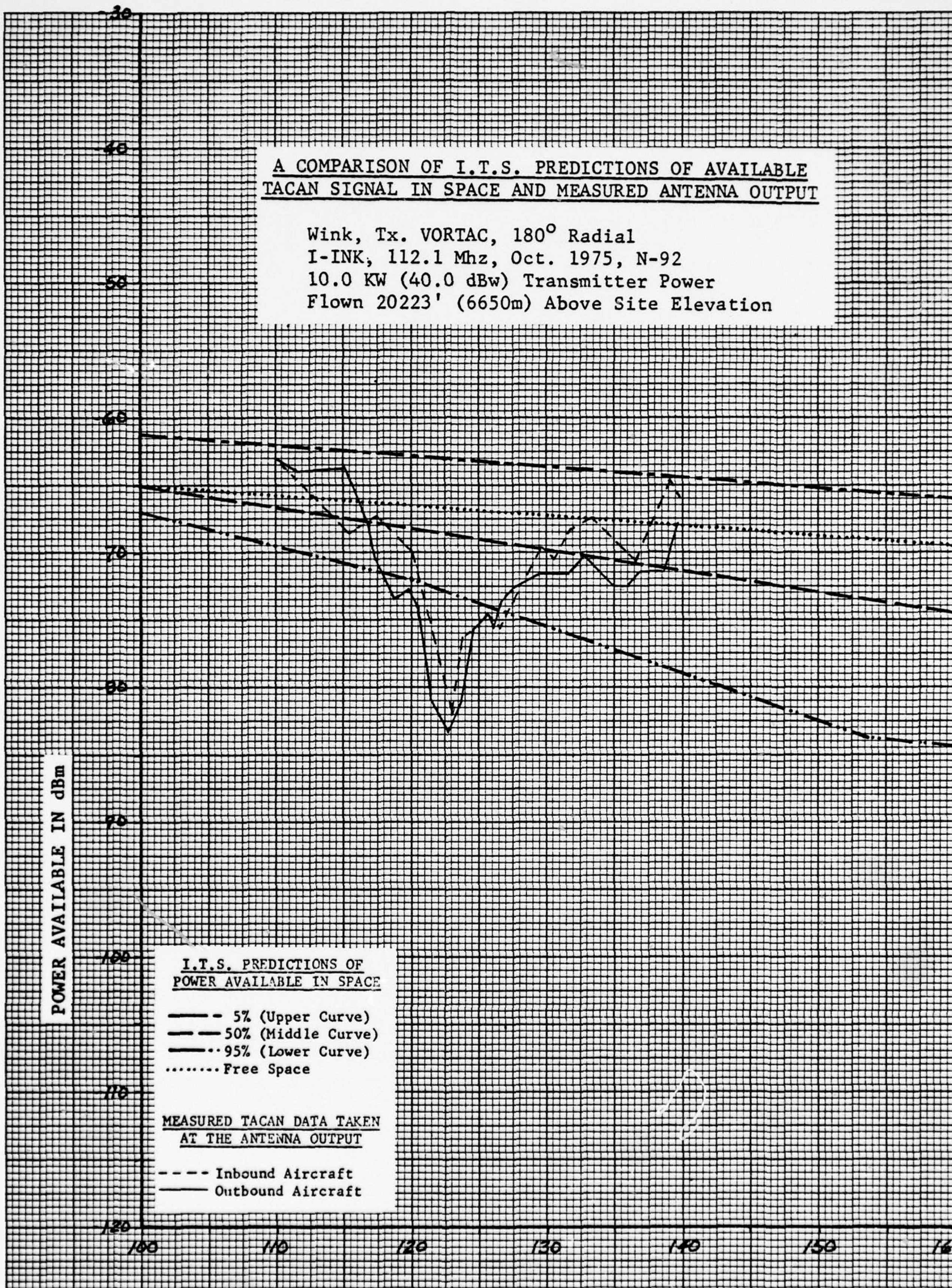
FIGURE H 18



A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Waco, Tx. VORTAC, 180° Radial
I-ACT, 115.3 Mhz, Oct. 1975, N-92
6.0 KW (37.8 dBw) Transmitter Power
Flown 18000' (5486m) Above Site Elevation
Measured Data From Outbound Flight
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
I.T.S. PREDICTIONS OF POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN AT THE ANTENNA OUTPUT
Outbound Aircraft
SPECTRUM MANAGEMENT STAFF, ARD-60
Submitted M. Androski
Approved J.L. Pierzga
Oct. 1977

FIGURE H 19



A COMPARISON OF I.T.S. PREDICTIONS OF AVAILABLE
TACAN SIGNAL IN SPACE AND MEASURED ANTENNA OUTPUT
Wink, Tx. VORTAC, 180° Radial
I-INK, 112.1 Mhz, Oct. 1975, N-92
10.0 KW (40.0 dBw) Transmitter Power
Flown 20223' (6650m) Above Site Elevation
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
POWER AVAILABLE IN dBm
I.T.S. PREDICTIONS OF
POWER AVAILABLE IN SPACE
5% (Upper Curve)
50% (Middle Curve)
95% (Lower Curve)
Free Space
MEASURED TACAN DATA TAKEN
AT THE ANTENNA OUTPUT
Inbound Aircraft
Outbound Aircraft
100
110
120
130
140
150
160
DISTANCE TO THE FACILITY IN nmi
SPECTRUM MANAGEMENT STAFF, ARD-60
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FIGURE H 20

APPENDIX I
ITS COMPUTER OUTPUTS
FOR APPENDIXES G AND H

The predicted data in Appendixes G and H are based on the computer outputs contained in this Appendix. A total of 40 graphs are shown, one for each VOR and TACAN at each of the 20 VORTAC stations. The major difference between the graphs in this Appendix and the graphs in Appendix E is in the way terrain was considered. In Appendix E, predictions were made for "four thirds smooth earth." Basically, this means that terrain was assumed to be very smooth. In this Appendix, consideration was given to the terrain on the specific azimuth flown at each site. Among the changes required, were the following:

1. The horizon parameters generated by the ECAC terrain data file (see Table F-1, page F-42) were used in the predictions.

2. The terrain reference planes (see Table I-1, page I-2) were chosen on the basis of the terrain profiles in Appendix F.

3. An ITS program, using the ECAC terrain data, was used as an aid in choosing the surface refractivity (N_s) and terrain roughness parameter (Δ h). See Table I-1, page I-2.

Since the terrain is different at each site, the predictions are different as well. Consequently, it is no longer possible to compare predictions and all measured data on only four graphs as was done earlier in this report (Figures 1 through 4).

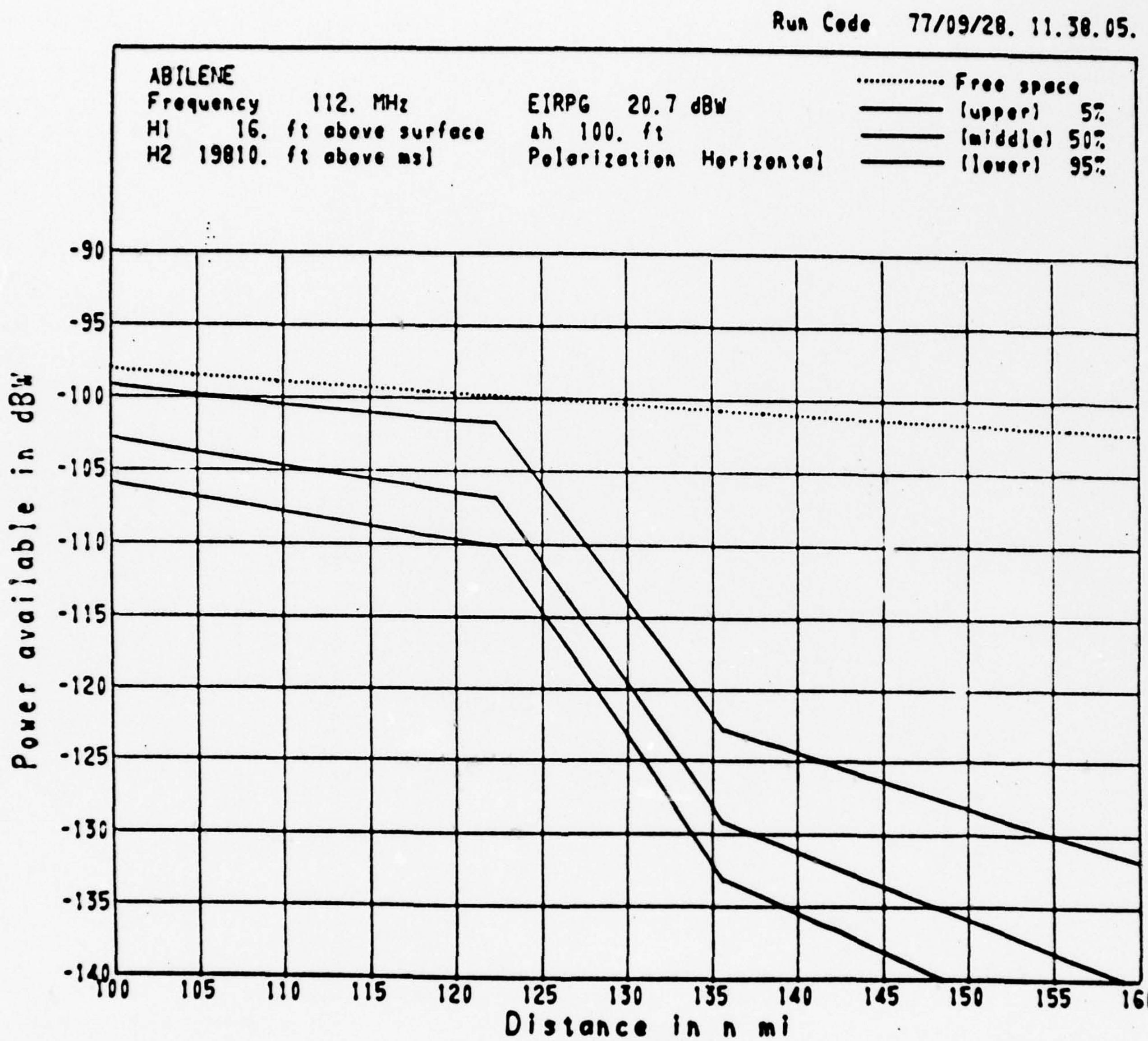
Although the ITS/FAA model is capable of taking terrain into account, a certain amount of judgment is required in choosing some of the input parameters which describe terrain. The ECAC terrain profiles can be used as a guide. Computer programs which analyze terrain can also serve as an aid. In the final analysis, the choice of certain input parameters is a matter of experienced judgment. As a result, taking terrain into account in signal strength predictions is a more time consuming matter than the usual predictions for "four thirds smooth earth."

TABLE I-1

ITS MODEL INPUTS

	REFRACTIVITY		TERRAIN	
	NS	Effective Earth Radius	Δh	Reference Plane
Abilene, Tx.	305	4480	100	1780
Albuquerque, N.M.	292	4209	300	5471
Amarillo, Tx.	298	4335	25	3440
Cimarron, N.M.	293	4187	300	6100
El Paso, Tx.	293	4279	350	4000
Greater Southwest, Tx.	315	4666	200	500
Junction, Tx.	307	4487	350	1900
Las Vegas, N.M.	293	4161	50	6790
Millsap, Tx.	310	4595	100	800
Oklahoma City, Ok.	307	4528	100	1350
Pioneer, Ok.	307	4561	100	920
Roswell, N.M.	295	4310	100	3600
San Angelo, Tx.	305	4473	200	1900
San Antonio, Tx.	317	4665	200	700
Texico, Tx.	295	4288	30	4030
Truth or Consequences, N.M.	295	4251	500	4800
Tucumeari, N.M.	293	4279	100	4000
Tulsa, Ok.	310	4597	100	780
Waco, Tx.	312	4639	100	500
Wink, Tx..	295	4351	100	2819

212


Run Code 77/09/28. 11.38.05.
ABILENE
Frequency 112. MHz
H1 16. ft above surface
H2 19810. ft above msl
EIRPG 20.7 dBW
Δh 100. ft
Polarization Horizontal
Free space
(upper) 5%
(middle) 50%
(lower) 95%
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
Power available in dBW
100
105
110
115
120
125
130
135
140
145
150
155
160
Distance in n mi
FIGURE I 1

PARAMETERS FOR ITS PROPAGATION MODEL APR 77
77/09/28. 11.38.05. RUN

POWER AVAILABLE FOR ABILENE
REQUIRED OR FIXED

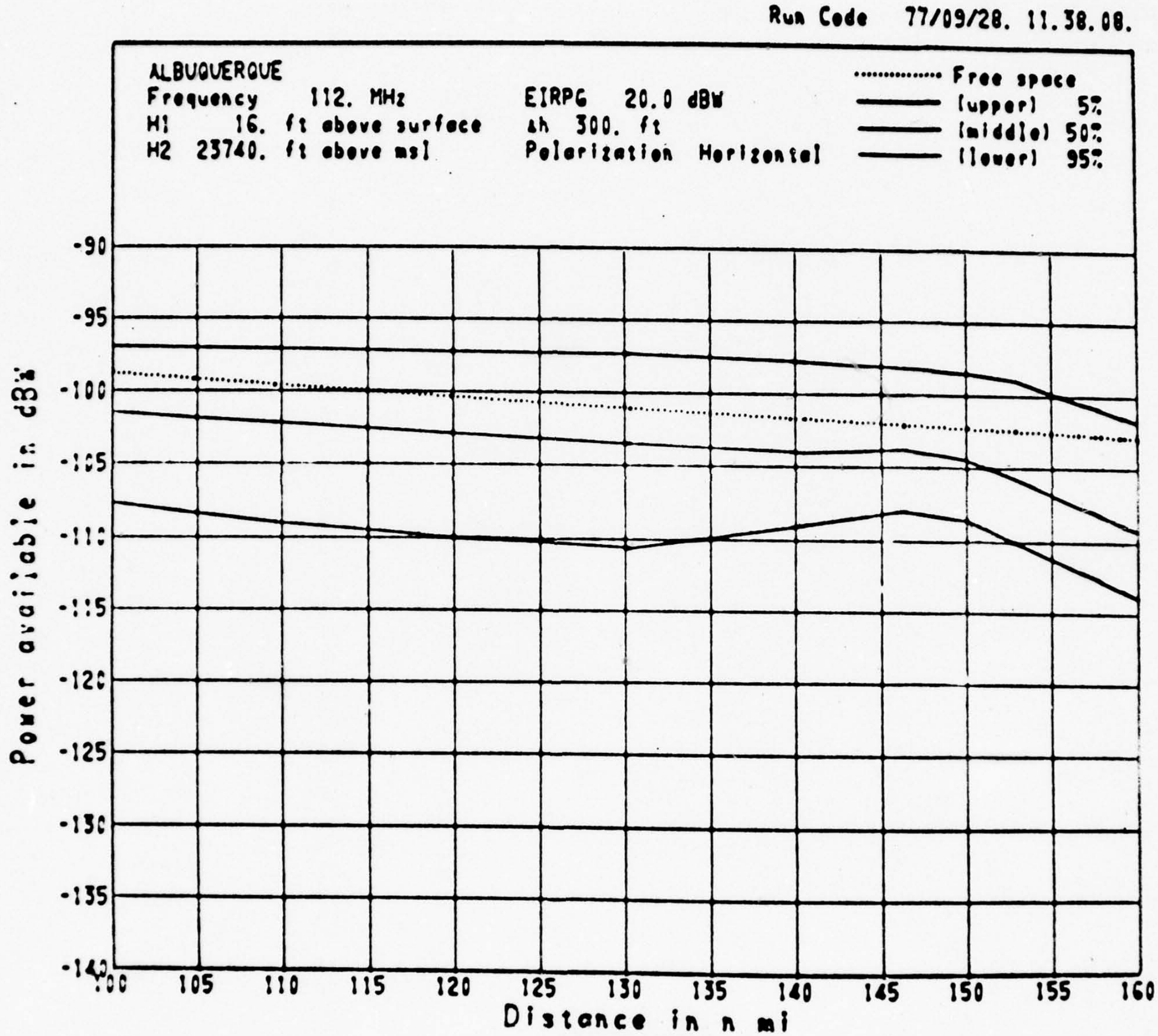
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE: 19810. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT: 16.0 FT ABOVE SITE SURFACE
FREQUENCY: 112. MHZ

SPECIFICATION OPTIONAL

AIRCRAFT ANTENNA TYPE: ISOTROPIC
POLARIZATION: HORIZONTAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL: 1800. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN: 20.7 DBW
FACILITY ANTENNA TYPE: 4-LOOP ARRAY (COSINE VERTICAL PATTERN)
POLARIZATION: HORIZONTAL
COUNTERPOISE DIAMETER: 52. FT
HEIGHT: 12. FT ABOVE SITE SURFACE
SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE: 12.25 N MI FROM FACILITY
ELEVATION ANGLE: 0/21/23 DEG/MIN/SEC ABOVE HORIZONTAL*
HEIGHT: 2390. FT ABOVE MSL
REFRACTIVITY:
EFFECTIVE EARTH RADIUS: 4480. N MI*
MINIMUM MONTHLY MEAN: 305. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING: CONTRIBUTES TO VARIABILITY
SURFACE TYPE: AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 1807. FT ABOVE MSL
TERRAIN PARAMETER: 130. FT
TIME AVAILABILITY: FOR INSTANTANEOUS LEVELS EXCEEDED

* COMPUTED VALUE

214



Run Code 77/09/28. 11.38.08.
ALBUQUERQUE
Frequency 112. MHz
H1 16. ft above surface
H2 23740. ft above msl
EIRPG 20.0 dBW
Δh 300. ft
Polarization Horizontal
Free space
(upper) 5%
(middle) 50%
(lower) 95%
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
100
105
110
115
120
125
130
135
140
145
150
155
160
Power available in dBW
Distance in n mi

FIGURE I 2

```
           PARAMETERS FOR ITS PROPAGATION MODEL  APR 77
                 77/09/28.   11.38.08. RUN

              POWER AVAILABLE FOR ALBUQUERQUE
                 REQUIRED OR FIXED
                 -----------------
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  23740. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:     16.0 FT ABOVE SITE SURFACE
FREQUENCY:  112. MHZ

              SPECIFICATION OPTIONAL
              ----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
    POLARIZATION: HORIZONTAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:  5471. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   20.0 DBW
FACILITY ANTENNA TYPE:  4-LOOP ARRAY (COSINE VERTICAL PATTERN)
    POLARIZATION: HORIZONTAL
    COUNTERPOISE DIAMETER:  32. FT
        HEIGHT:  12. FT ABOVE SITE SURFACE
        SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:  14.76 N MI FROM FACILITY
    ELEVATION ANGLE:   -0/16/38 DEG/MIN/SEC ABOVE HORIZONTAL*
    HEIGHT: 5471. FT ABOVE MSL
REFRACTIVITY:
    EFFECTIVE EARTH RADIUS: 4239. N MI*
    MINIMUM MONTHLY MEAN: 292. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 5732. FT ABOVE MSL
TERRAIN PARAMETER: 300. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


* COMPUTED VALUE
```

I 6

216

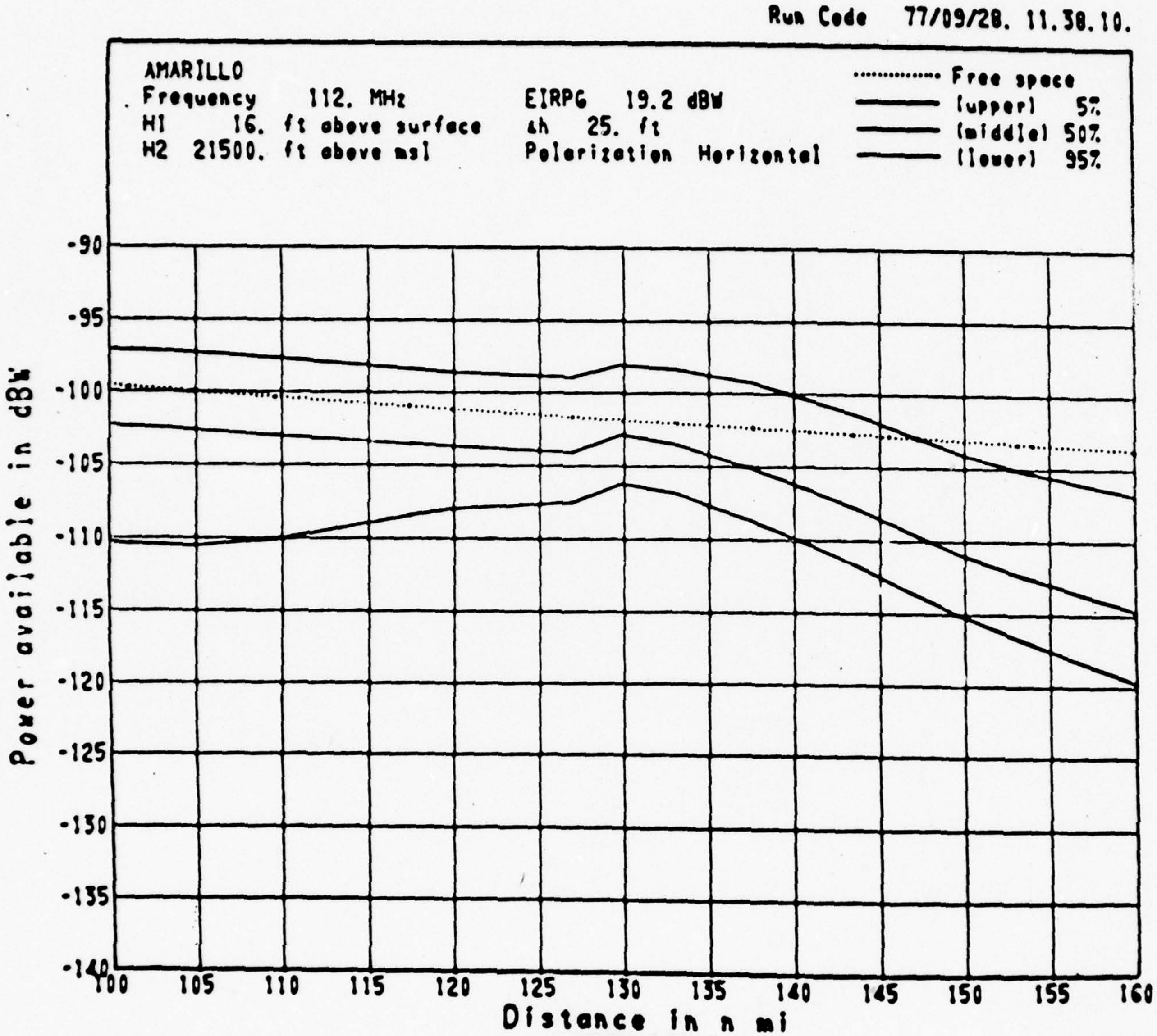


FIGURE I 3

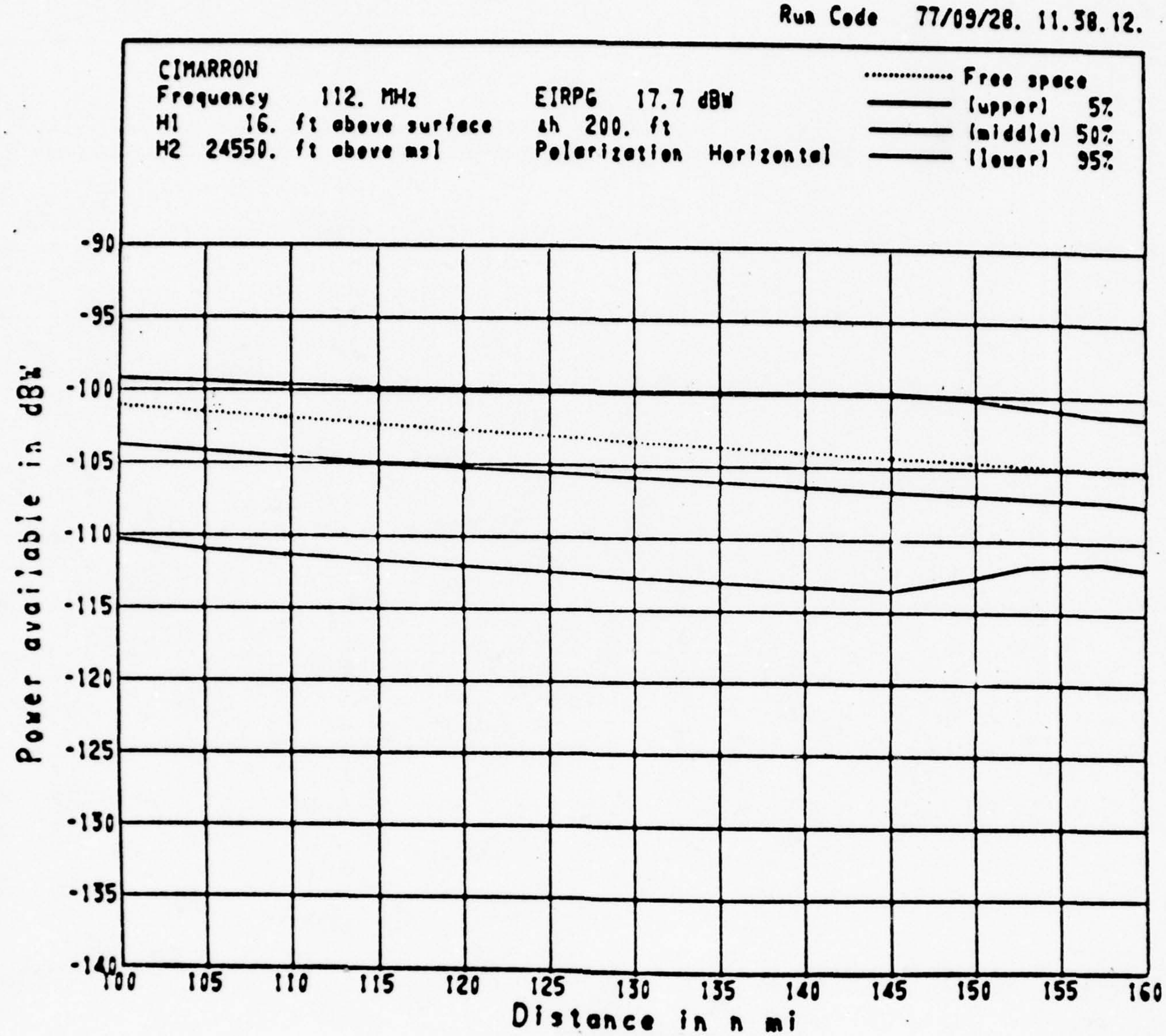
217

```
              PARAMETERS FOR ITS PROPAGATION MODEL  APR 77
                   77/09/28.   11.38.10. RUN

                    POWER AVAILABLE FOR AMARILLO
                      REQUIRED OR FIXED
                      -----------------
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  21500. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:      16.0 FT ABOVE SITE SURFACE
FREQUENCY:  112. MHZ

                    SPECIFICATION OPTIONAL
                    ----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: HORIZONTAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:  3440. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   19.2 DBW
FACILITY ANTENNA TYPE:  4-LOOP ARRAY (COSINE VERTICAL PATTERN)
     POLARIZATION: HORIZONTAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:  12.50 N MI FROM FACILITY
     ELEVATION ANGLE:   -0/15/39 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT: 3440. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4335. N MI*
     MINIMUM MONTHLY MEAN: 296. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 3550. FT ABOVE MSL
TERRAIN PARAMETER:  25. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


* COMPUTED VALUE
```


Run Code 77/09/28. 11.38.12.
CIMARRON
Frequency 112. MHz
H1 16. ft above surface
H2 24550. ft above msl
EIRPG 17.7 dBW
Δh 200. ft
Polarization Horizontal
Free space
(upper) 5%
(middle) 50%
(lower) 95%
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
Power available in dBW
100
105
110
115
120
125
130
135
140
145
150
155
160
Distance in n mi
FIGURE I 4

```
              PARAMETERS FOR ITS PROPAGATION MODEL  APR 77
                      77/09/28.   11.38.12. RUN

                   POWER AVAILABLE FOR CIMARRON
                        REQUIRED OR FIXED
                        -----------------
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  24553. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:     16.0 FT ABOVE SITE SURFACE
FREQUENCY:  112. MHZ

                  SPECIFICATION OPTIONAL
                  ----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: HORIZONTAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:  6100. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:    17.7 DBW
FACILITY ANTENNA TYPE:  4-LOOP ARRAY (COSINE VERTICAL PATTERN)
     POLARIZATION: HORIZONTAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:  35.51 N MI FROM FACILITY
     ELEVATION ANGLE:   -0/19/42 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT: 6239. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4187. N MI*
     MINIMUM MONTHLY MEAN: 293. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 6545. FT ABOVE MSL
TERRAIN PARAMETER: 200. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


* COMPUTED VALUE
```

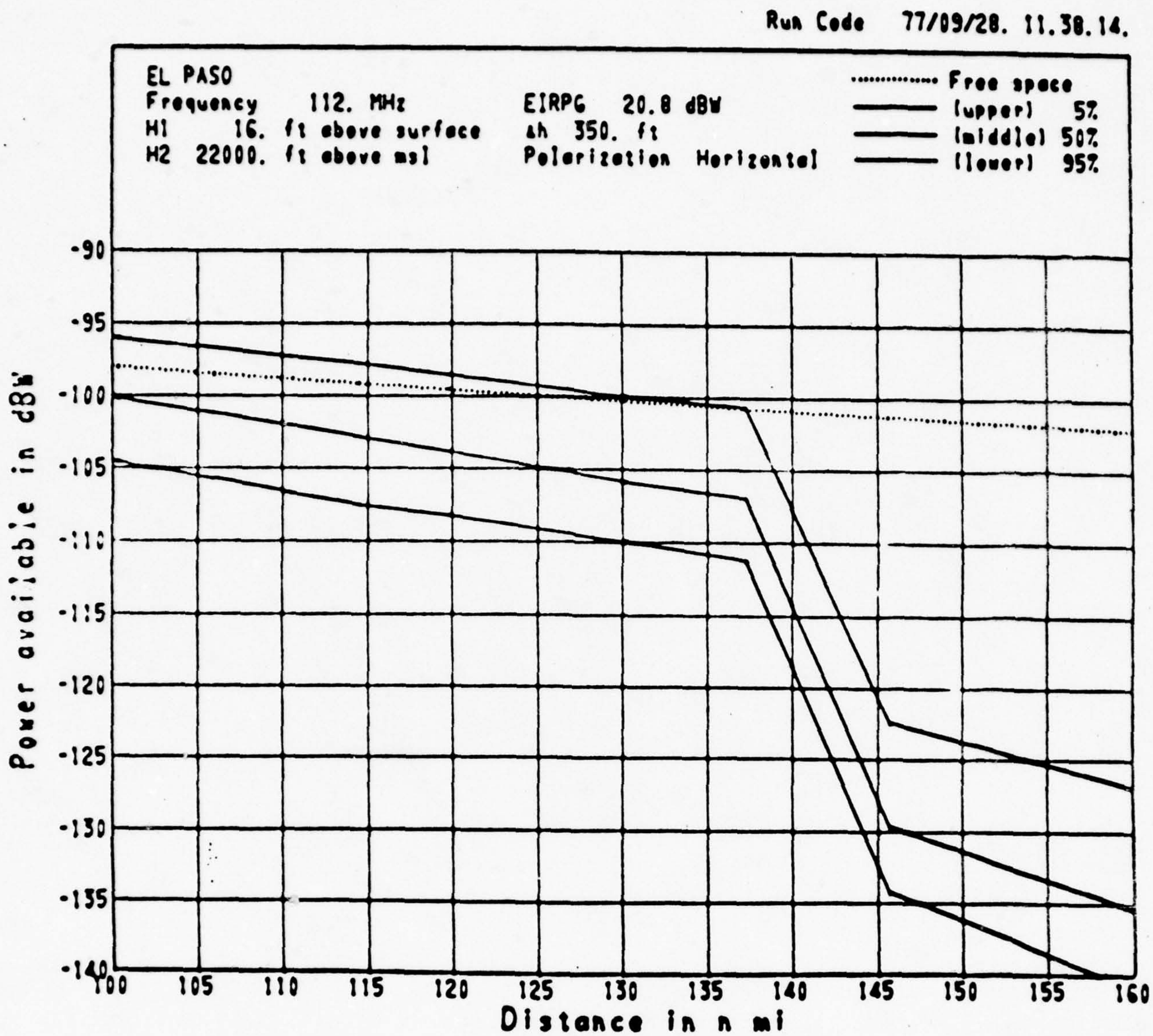

Run Code 77/09/28. 11.38.14.
EL PASO
Frequency 112. MHz
H1 16. ft above surface
H2 22000. ft above msl
EIRPG 20.8 dBW
Δh 350. ft
Polarization Horizontal
Free space
(upper) 5%
(middle) 50%
(lower) 95%
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
100
105
110
115
120
125
130
135
140
145
150
155
160
Power available in dBW
Distance in n mi

FIGURE I 5

```
              PARAMETERS FOR ITS PROPAGATION MODEL  APR 77
                      77/09/28.    11.38.14. RUN

                     POWER AVAILABLE FOR EL PASO
                      REQUIRED OR FIXED
                      -----------------
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  22000. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:     16.0 FT ABOVE SITE SURFACE
FREQUENCY:  112. MHZ

                    SPECIFICATION OPTIONAL
                    ----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: HORIZONTAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:  4000. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:    20.8 DBW
FACILITY ANTENNA TYPE:  4-LOOP ARRAY (COSINE VERTICAL PATTERN)
     POLARIZATION: HORIZONTAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
     DLT IS LESS THAN .1XDLST OR GREATER THAN 3XDLST
HORIZON OBSTACLE DISTANCE:  30.31 N MI FROM FACILITY
     ELEVATION ANGLE:    0/10/ 2 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT: 5208. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4279. N MI*
     MINIMUM MONTHLY MEAN: 293. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 4020. FT ABOVE MSL
TERRAIN PARAMETER: 350. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


* COMPUTED VALUE
```

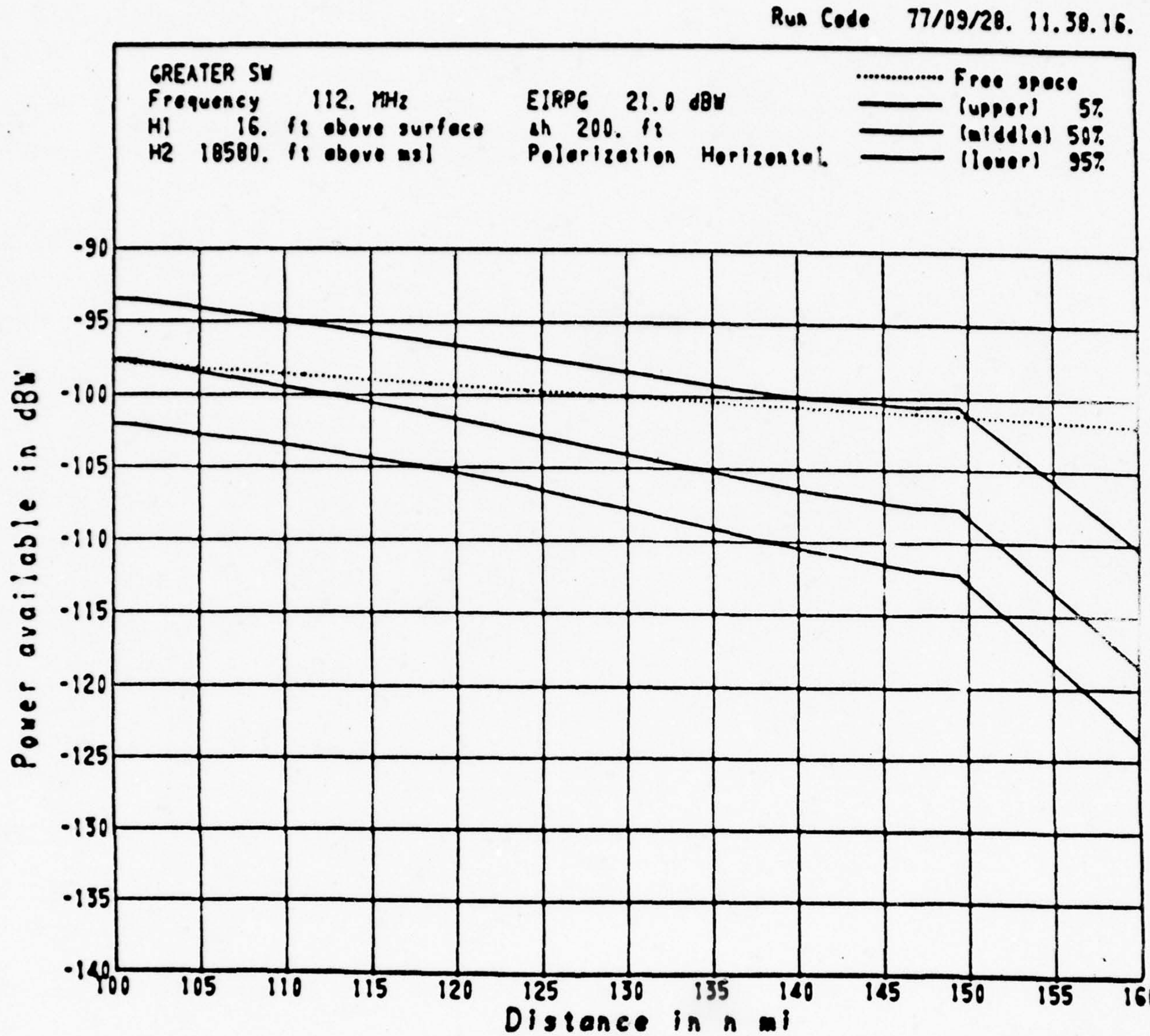

Run Code 77/09/28. 11.38.16.
GREATER SW
Frequency 112. MHz
H1 16. ft above surface
H2 18580. ft above msl
EIRPG 21.0 dBW
Δh 200. ft
Polarization Horizontal
Free space
(upper) 5%
(middle) 50%
(lower) 95%
Power available in dBW
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
100
105
110
115
120
125
130
135
140
145
150
155
160
Distance in n mi

FIGURE I 6

```
PAGE   1  77/09/28.  11.38.16.
                PARAMETERS FOR ITS PROPAGATION MODEL  APR 77
                         77/09/28.    11.38.16. RUN

                   POWER AVAILABLE FOR GREATER SW
                     REQUIRED OR FIXED
                     -----------------
       AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  18580. FT ABOVE MSL
       FACILITY (OR LOWER) ANTENNA HEIGHT:      16.0 FT ABOVE SITE SURFACE
       FREQUENCY:  112. MHZ

                   SPECIFICATION OPTIONAL
                   ----------------------
       AIRCRAFT ANTENNA TYPE:  ISOTROPIC
          POLARIZATION: HORIZONTAL
       EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:   500. FT
       EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   21.0 DBW
       FACILITY ANTENNA TYPE:  4-LOOP ARRAY (COSINE VERTICAL PATTERN)
          POLARIZATION: HORIZONTAL
          COUNTERPOISE DIAMETER:  52. FT
             HEIGHT:  12. FT ABOVE SITE SURFACE
             SURFACE: METALLIC
       HORIZON OBSTACLE DISTANCE:  23.25 N MI FROM FACILITY
          ELEVATION ANGLE:   -0/ 1/24 DEG/MIN/SEC ABOVE HORIZONTAL*
          HEIGHT:  855. FT ABOVE MSL
       REFRACTIVITY:
          EFFECTIVE EARTH RADIUS: 4666. N MI*
          MINIMUM MONTHLY MEAN: 315. N-UNITS AT SEA LEVEL
       SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
       SURFACE TYPE:  AVERAGE GROUND
       TERRAIN ELEVATION AT SITE:  545. FT ABOVE MSL
       TERRAIN PARAMETER: 200. FT
       TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


       * COMPUTED VALUE
```

Run Code 77/09/28. 11.39.48.

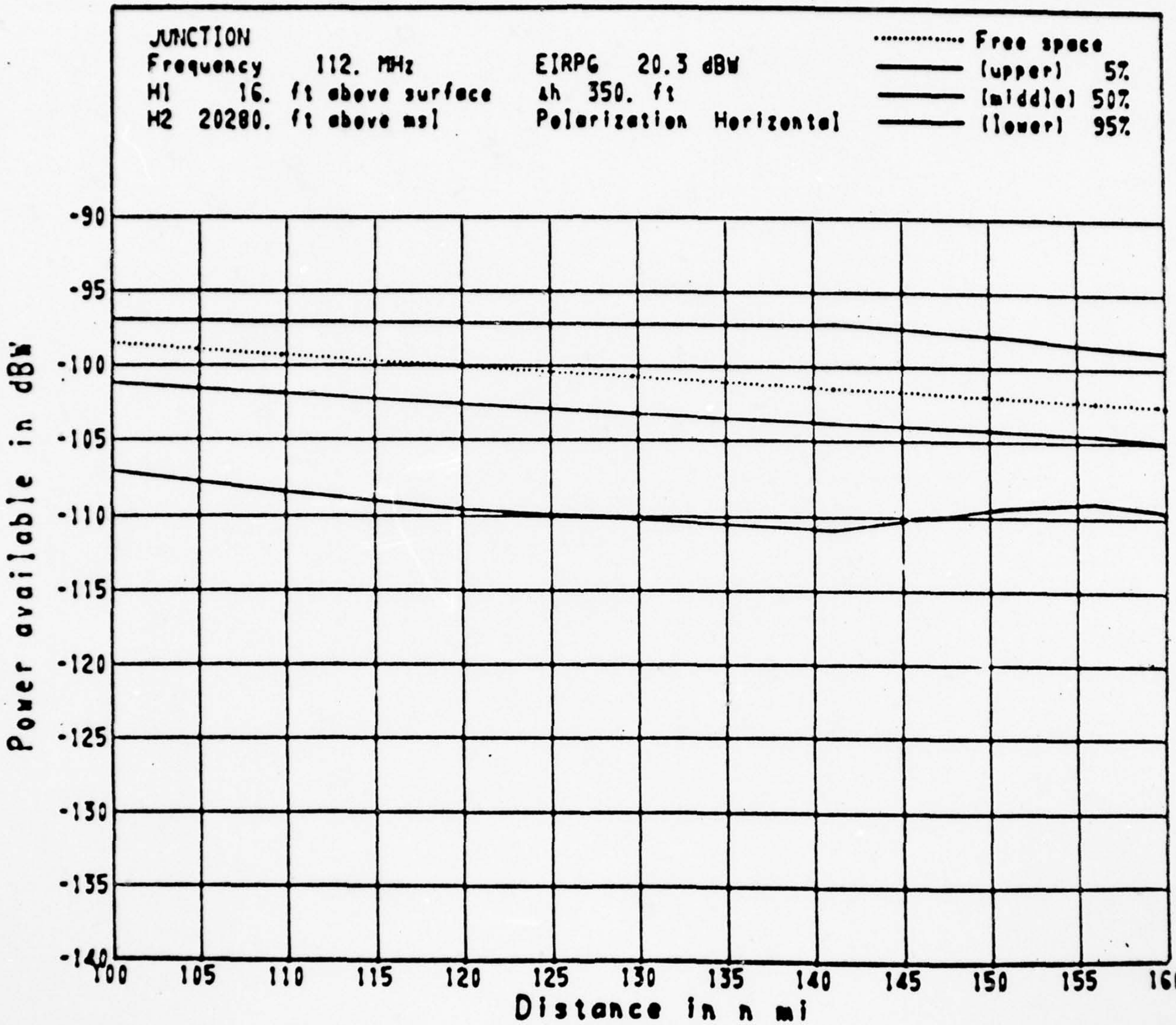


FIGURE I 7

PARAMETERS FOR ITS PROPAGATION MODEL APR 77
77/09/28. 11.39.48. RUN

POWER AVAILABLE FOR JUNCTION
REQUIRED OR FIXED

```
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  20280. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:     16.0 FT ABOVE SITE SURFACE
FREQUENCY:  112. MHZ
```

SPECIFICATION OPTIONAL

```
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: HORIZONTAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:  1900. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   20.3 DBW
FACILITY ANTENNA TYPE:  4-LOOP ARRAY (COSINE VERTICAL PATTERN)
     POLARIZATION: HORIZONTAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:  24.08 N MI FROM FACILITY
     ELEVATION ANGLE:   -0/10/36 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT: 2195. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4467. N MI*
     MINIMUM MONTHLY MEAN: 307. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 2238. FT ABOVE MSL
TERRAIN PARAMETER: 350. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED
```

* COMPUTED VALUE

Run Code 77/09/28. 11.39.51.

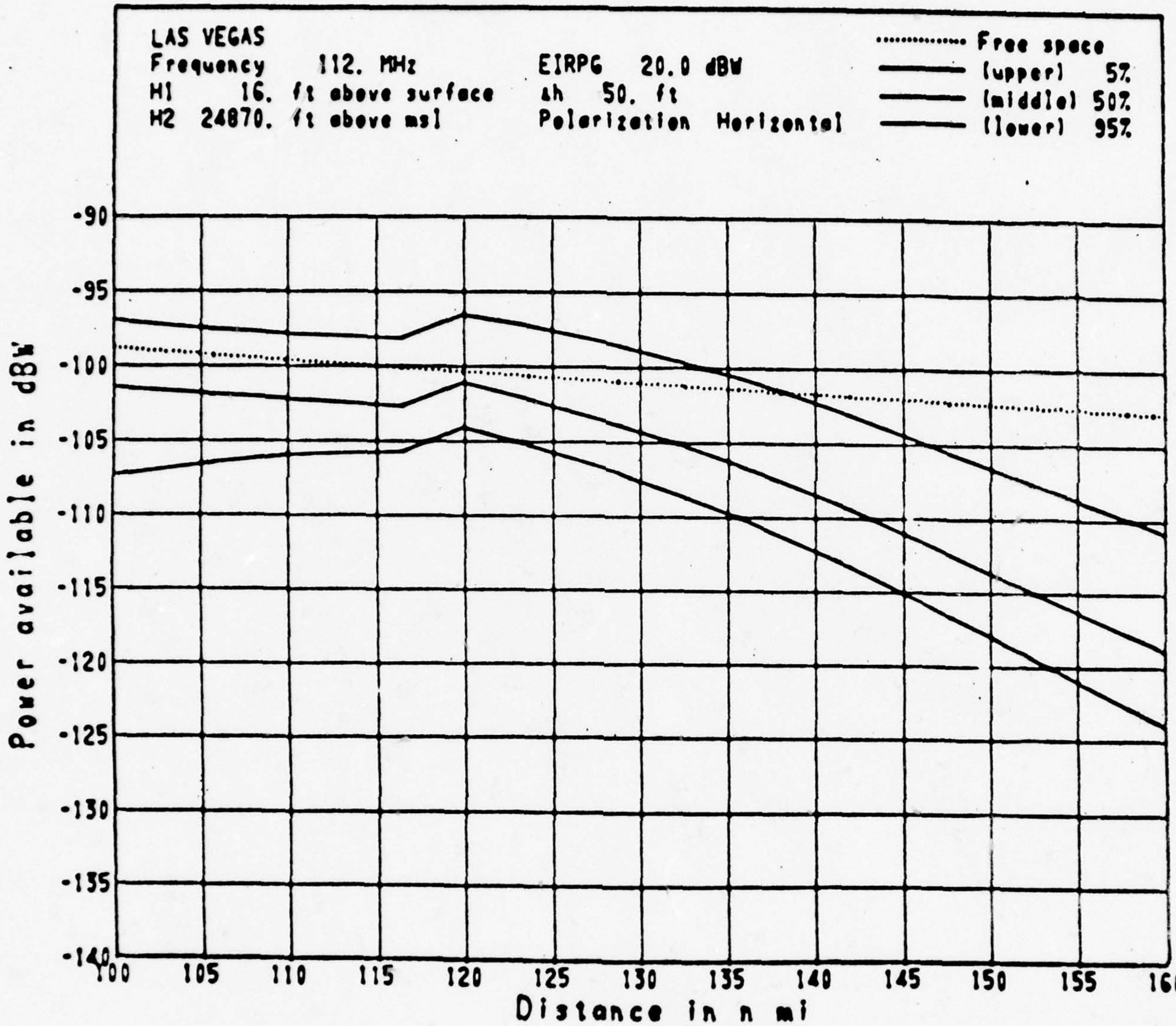


FIGURE I 8

```
              PARAMETERS FOR ITS PROPAGATION MODEL  APR 77
                     77/09/28.   11.39.51. RUN

                 POWER AVAILABLE FOR LAS VEGAS
                      REQUIRED OR FIXED
                      -----------------
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  24873. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:       16.0 FT ABOVE SITE SURFACE
FREQUENCY:  112. MHZ

                 SPECIFICATION OPTIONAL
                 ----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: HORIZONTAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:  6793. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   20.0 DBW
FACILITY ANTENNA TYPE:  4-LOOP ARRAY (COSINE VERTICAL PATTERN)
     POLARIZATION: HORIZONTAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:  10.94 N MI FROM FACILITY
     ELEVATION ANGLE:   -0/ 3/47 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT: 6900. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4161. N MI*
     MINIMUM MONTHLY MEAN: 293. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 6670. FT ABOVE MSL
TERRAIN PARAMETER:  50. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


* COMPUTED VALUE
```

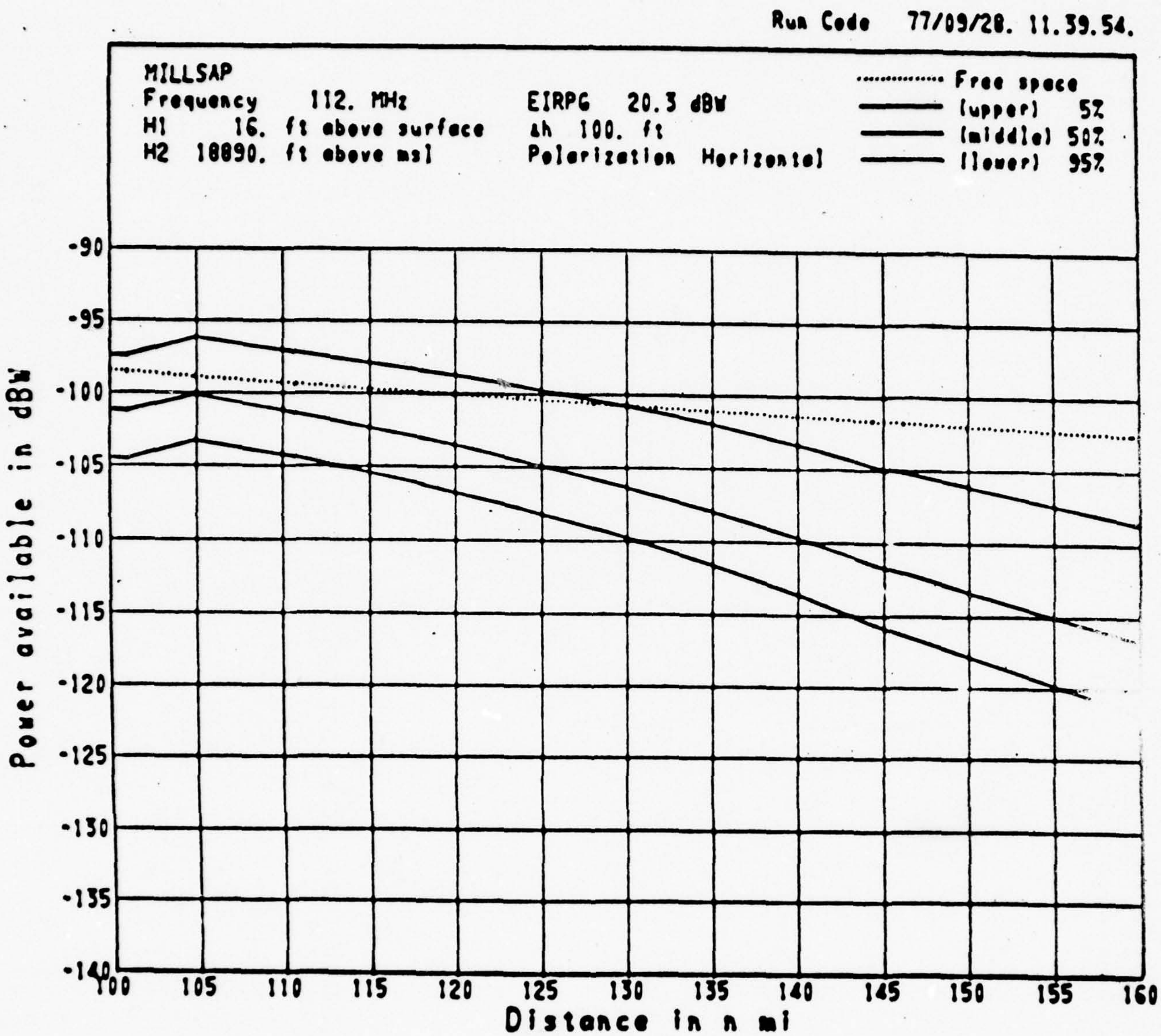

Run Code 77/09/28. 11.39.54.
MILLSAP
Frequency 112. MHz
H1 16. ft above surface
H2 18090. ft above msl
EIRPG 20.3 dBW
Δh 100. ft
Polarization Horizontal
Free space
(upper) 5%
(middle) 50%
(lower) 95%
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
Power available in dBW
100
105
110
115
120
125
130
135
140
145
150
155
160
Distance in n mi

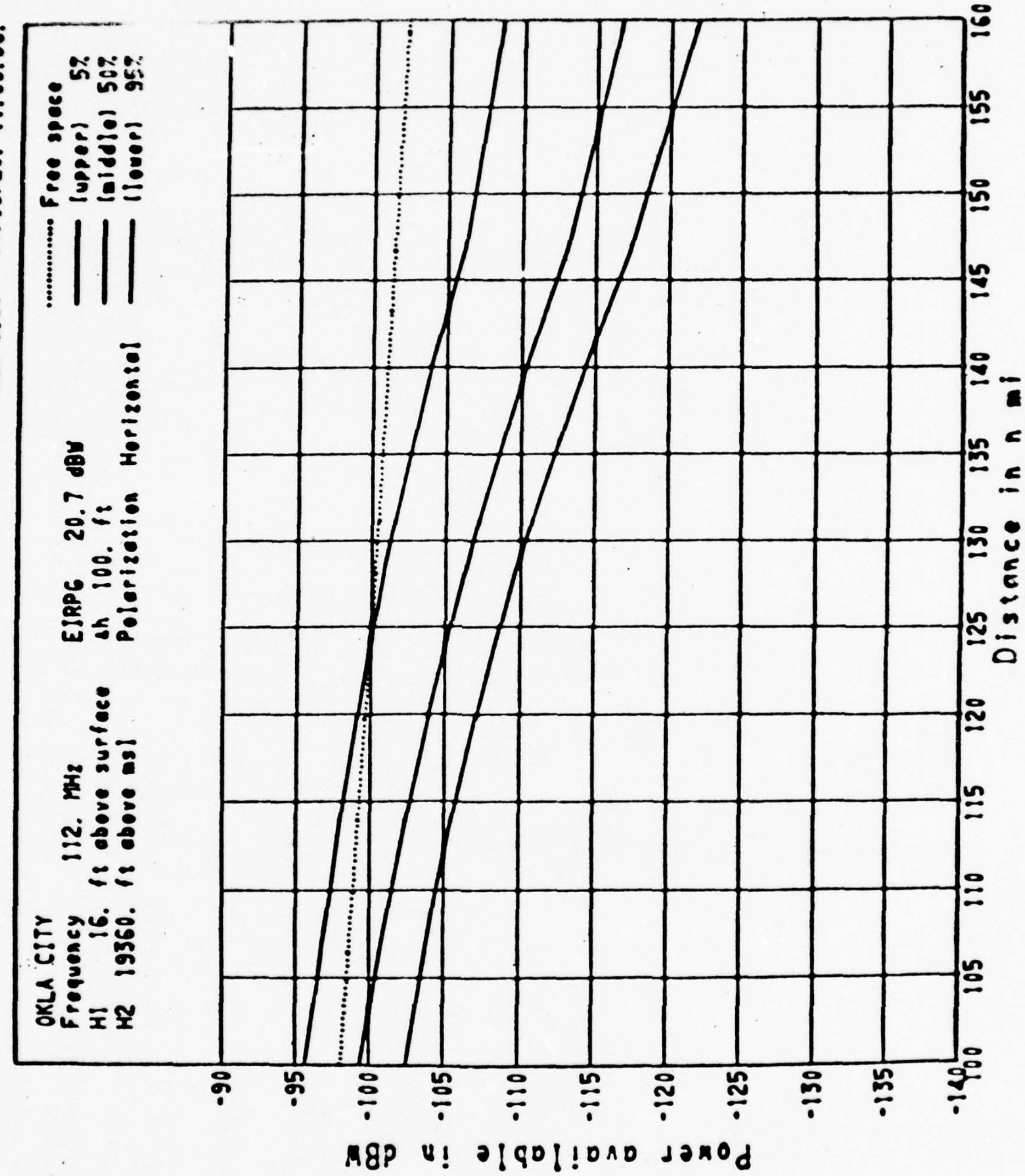
FIGURE I 9

```
                PARAMETERS FOR ITS PROPAGATION MODEL  APR 77
                         77/09/28.   11.39.54. RUN

                       POWER AVAILABLE FOR MILLSAP
                           REQUIRED OR FIXED
                           -----------------
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  16890. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:      16.0 FT ABOVE SITE SURFACE
FREQUENCY:  112. MHZ

                     SPECIFICATION OPTIONAL
                     ----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: HORIZONTAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:   800. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   20.3 DBW
FACILITY ANTENNA TYPE:  4-LOOP ARRAY (COSINE VERTICAL PATTERN)
     POLARIZATION: HORIZONTAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:    4.50 N MI FROM FACILITY
     ELEVATION ANGLE:   -0/ 2/46 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT:  852. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4595. N MI*
     MINIMUM MONTHLY MEAN: 310. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE:  845. FT ABOVE MSL
TERRAIN PARAMETER: 100. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


* COMPUTED VALUE
```



Run Code 77/09/28. 11.39.56.
OKLA CITY
Frequency 112. MHz
H1 16. ft above surface
H2 19360. ft above msl
EIRPG 20.7 dBW
Δh 100. ft
Polarization Horizontal
Free space
(upper) 5%
(middle) 50%
(lower) 95%
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
Power available in dBW
100
105
110
115
120
125
130
135
140
145
150
155
160
Distance in n mi

FIGURE I 10

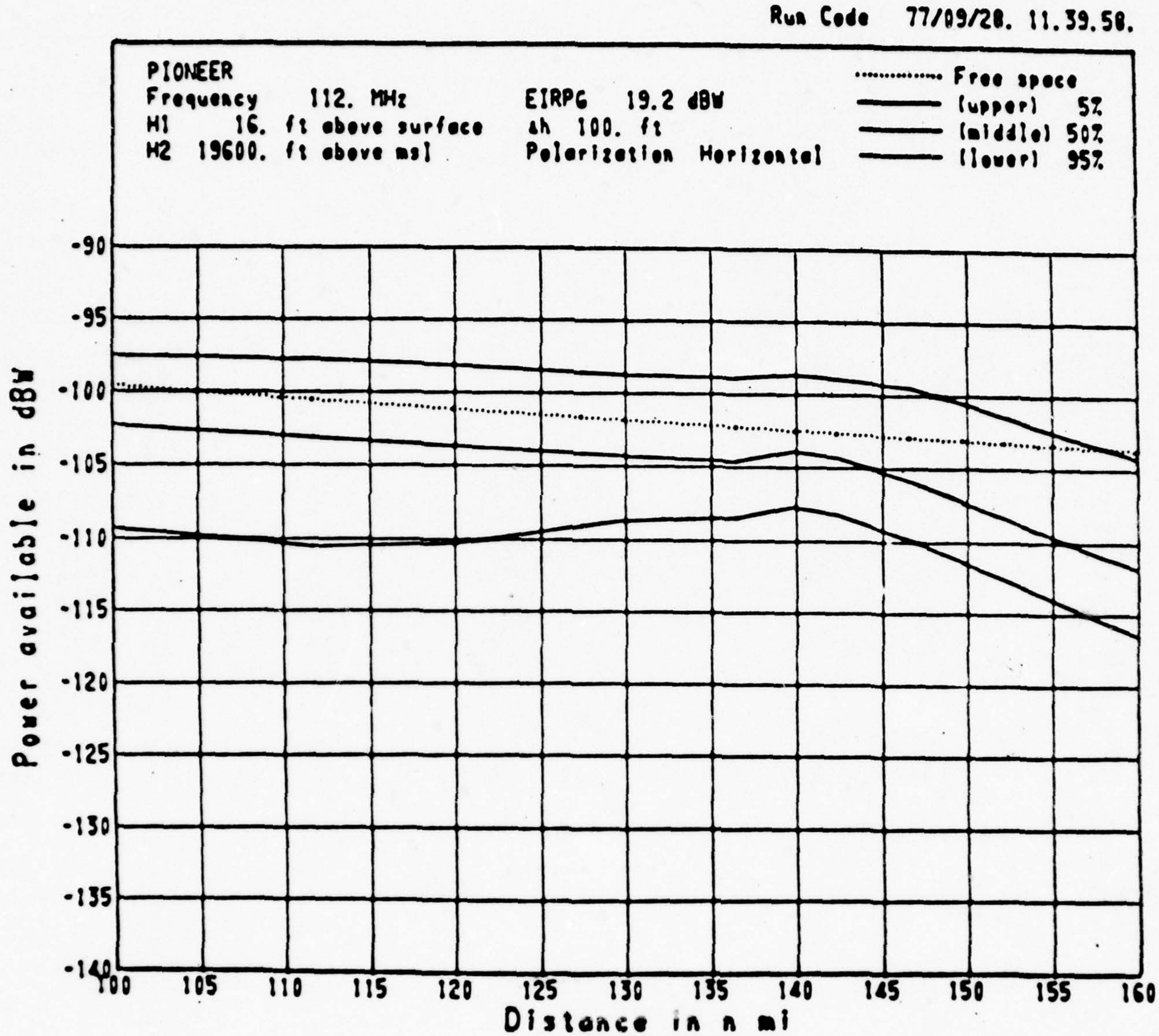
```
             PARAMETERS FOR ITS PROPAGATION MODEL  APR 77
                     77/09/28.   11.39.56. PUN

                   POWER AVAILABLE FOR OKLA CITY
                     REQUIRED OR FIXED
                     -----------------
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  19360. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:     16.0 FT ABOVE SITE SURFACE
FREQUENCY:  112. MHZ

                  SPECIFICATION OPTIONAL
                  ----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: HORIZONTAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:  1353. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   20.7 DBW
FACILITY ANTENNA TYPE:  4-LOOP ARRAY (COSINE VERTICAL PATTERN)
     POLARIZATION: HORIZONTAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:   4.50 N MI FROM FACILITY
     ELEVATION ANGLE:   -1/ 4/43 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT: 1382. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4528. N MI*
     MINIMUM MONTHLY MEAN: 307. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 1390. FT ABOVE MSL
TERRAIN PARAMETER: 100. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


* COMPUTED VALUE
```


232



Run Code 77/09/28. 11.39.58.
PIONEER
Frequency 112. MHz
H1 16. ft above surface
H2 19600. ft above msl
EIRPG 19.2 dBW
Δh 100. ft
Polarization Horizontal
Free space
(upper) 5%
(middle) 50%
(lower) 95%
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
Power available in dBW
100
105
110
115
120
125
130
135
140
145
150
155
160
Distance in n mi

FIGURE I 11

PARAMETERS FOR ITS PROPAGATION MODEL APR 77
77/09/28. 11.39.58. RUN

POWER AVAILABLE FOR PIONEER
REQUIRED OR FIXED

```
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  19600. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:      16.0 FT ABOVE SITE SURFACE
FREQUENCY:  112. MHZ
```

SPECIFICATION OPTIONAL

```
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: HORIZONTAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:   920. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:    19.2 DBW
FACILITY ANTENNA TYPE:  4-LOOP ARRAY (COSINE VERTICAL PATTERN)
     POLARIZATION: HORIZONTAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:  11.25 N MI FROM FACILITY
     ELEVATION ANGLE:   -0/ 8/36 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT:  960. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4561. N MI*
     MINIMUM MONTHLY MEAN: 307. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 1051. FT ABOVE MSL
TERRAIN PARAMETER: 100. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED
```

* COMPUTED VALUE

234

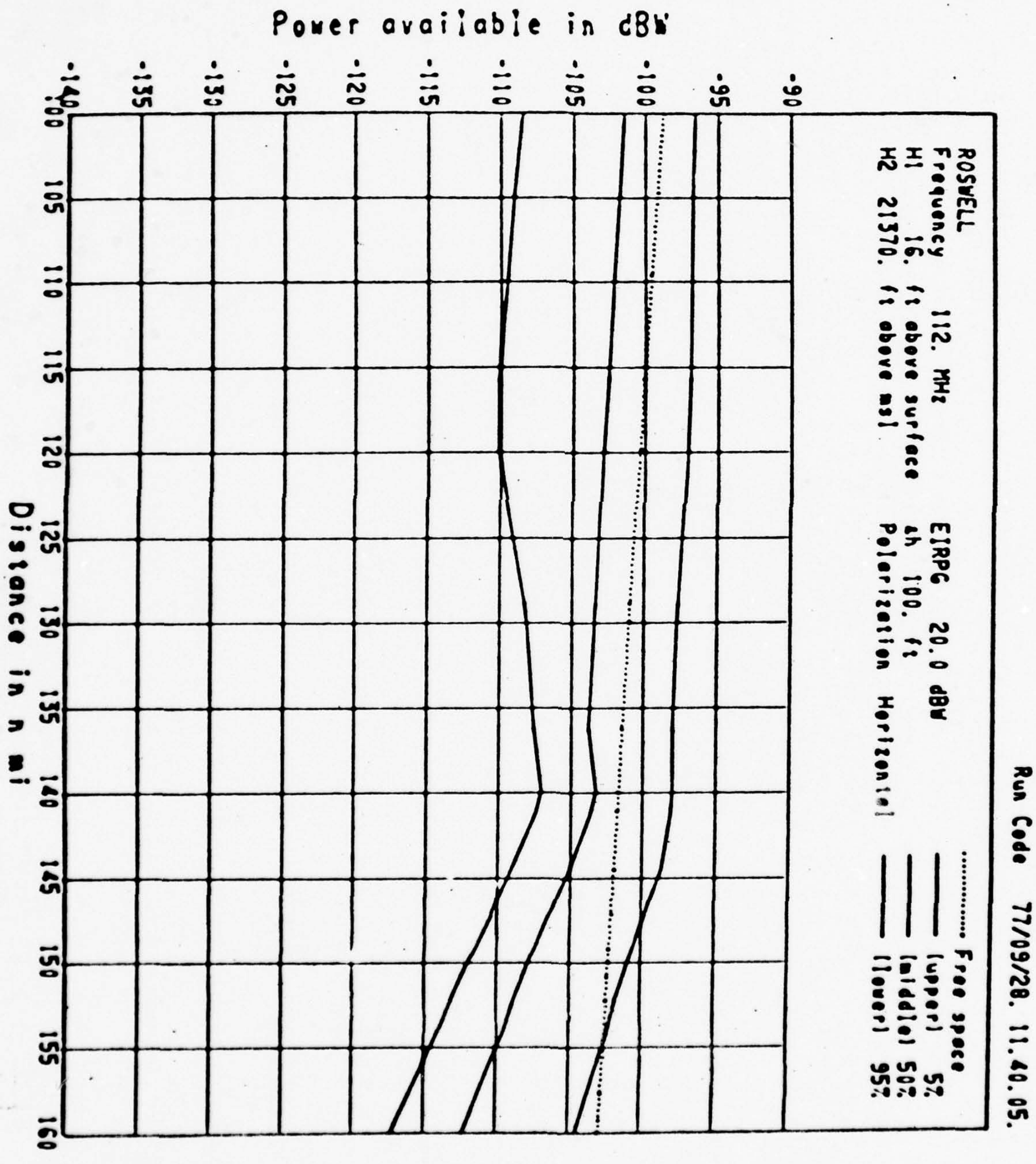

Power available in dBW
-140
-135
-130
-125
-120
-115
-110
-105
-100
-95
-90
100
105
110
115
120
125
130
135
140
145
150
155
160
Distance in n mi
ROSWELL
Frequency 112. MHz
H1 16. ft above surface
H2 21370. ft above msl
EIRPG 20.0 dBW
Δh 100. ft
Polarization Horizontal
Run Code 77/09/28. 11.40.05.
Free space
(upper) 5%
(middle) 50%
(lower) 95%

FIGURE I 12

```
            PARAMETERS FOR ITS PROPAGATION MODEL  APR 77
                      77/09/28.   11.40.05. RUN

                  POWER AVAILABLE FOR ROSWELL
                   REQUIRED OR FIXED
                   -----------------
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  21370. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:     16.0 FT ABOVE SITE SURFACE
FREQUENCY:  112. MHZ

                SPECIFICATION OPTIONAL
                ----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: HORIZONTAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:  3600. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   20.0 DBW
FACILITY ANTENNA TYPE:  4-LOOP ARRAY (COSINE VERTICAL PATTERN)
     POLARIZATION: HORIZONTAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:  25.25 N MI FROM FACILITY
     ELEVATION ANGLE:   -0/12/ 2 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT: 3698. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4310. N MI*
     MINIMUM MONTHLY MEAN: 295. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 3770. FT ABOVE MSL
TERRAIN PARAMETER: 100. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


* COMPUTED VALUE
```


(236)

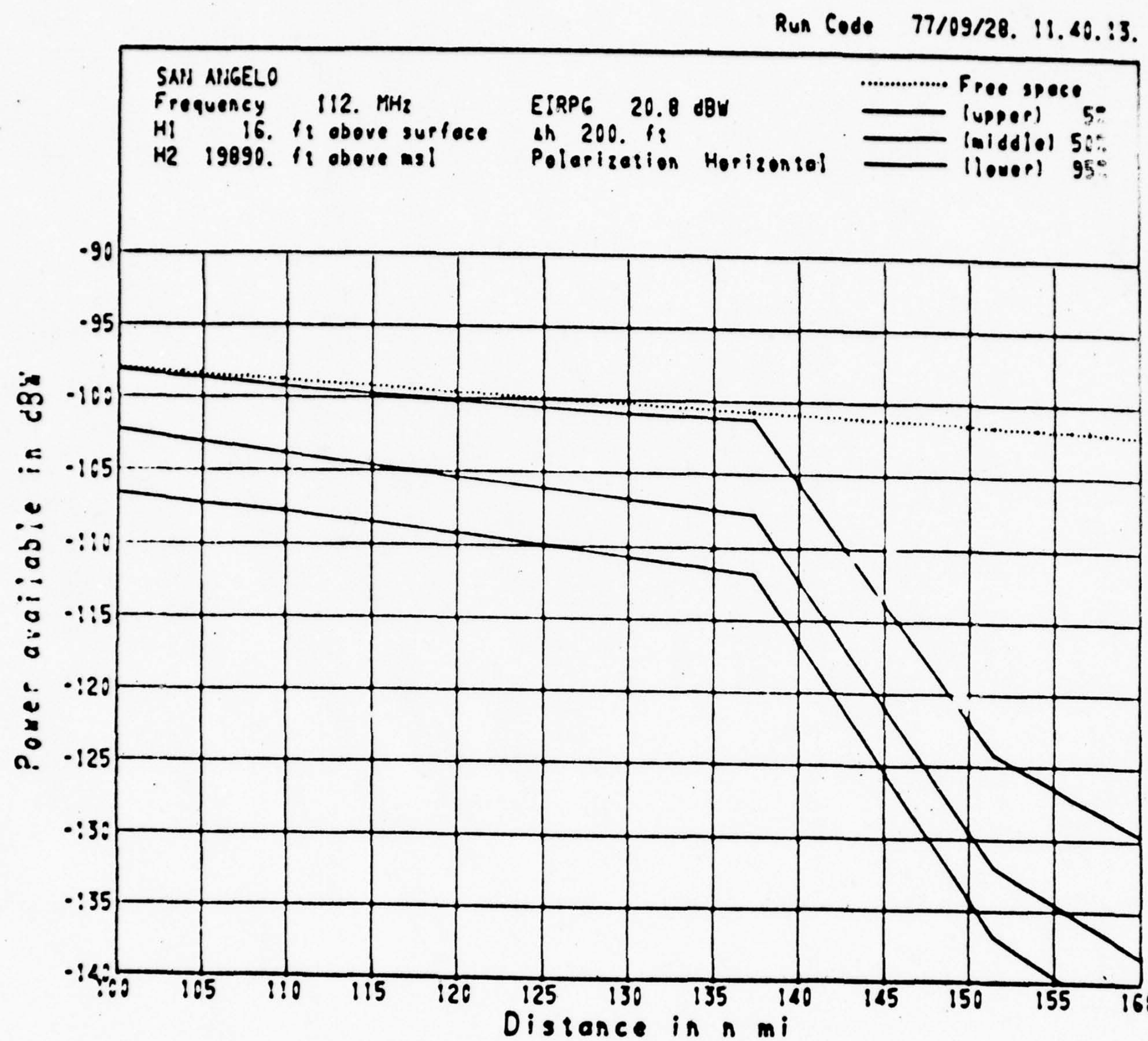

Run Code 77/09/28. 11.40.13.
SAN ANGELO
Frequency 112. MHz
H1 16. ft above surface
H2 19890. ft above msl
EIRPG 20.8 dBW
Δh 200. ft
Polarization Horizontal
Free space
(upper) 5%
(middle) 50%
(lower) 95%
Power available in dBW
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
100
105
110
115
120
125
130
135
140
145
150
155
160
Distance in n mi

FIGURE I 13

```
PAGE   1  77/09/26.  11.40.13.
               PARAMETERS FOR ITS PROPAGATION MODEL  APR 77
                       77/09/26.   11.40.13. RUN

                      POWER AVAILABLE FOR SAN ANGELO
                         REQUIRED OR FIXED
                         -----------------
           AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  19850. FT ABOVE MSL
           FACILITY (OR LOWER) ANTENNA HEIGHT:     16.0 FT ABOVE SITE SURFACE
           FREQUENCY:  112. MHZ

                      SPECIFICATION OPTIONAL
                      ----------------------
           AIRCRAFT ANTENNA TYPE:  ISOTROPIC
              POLARIZATION: HORIZONTAL
           EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:  1900. FT
           EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   20.6 DBW
           FACILITY ANTENNA TYPE:  4-LOOP ARRAY (COSINE VERTICAL PATTERN)
              POLARIZATION: HORIZONTAL
              COUNTERPOISE DIAMETER:  52. FT
                 HEIGHT:  12. FT ABOVE SITE SURFACE
                 SURFACE: METALLIC
           HORIZON OBSTACLE DISTANCE:  14.25 N MI FROM FACILITY
              ELEVATION ANGLE:    0/ 7/35 DEG/MIN/SEC ABOVE HORIZONTAL*
              HEIGHT: 2245. FT ABOVE MSL
           REFRACTIVITY:
              EFFECTIVE EARTH RADIUS: 4473. N MI*
              MINIMUM MONTHLY MEAN: 305. N-UNITS AT SEA LEVEL
           SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
           SURFACE TYPE:  AVERAGE GROUND
           TERRAIN ELEVATION AT SITE: 1900. FT ABOVE MSL
           TERRAIN PARAMETER: 200. FT
           TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


           * COMPUTED VALUE
```

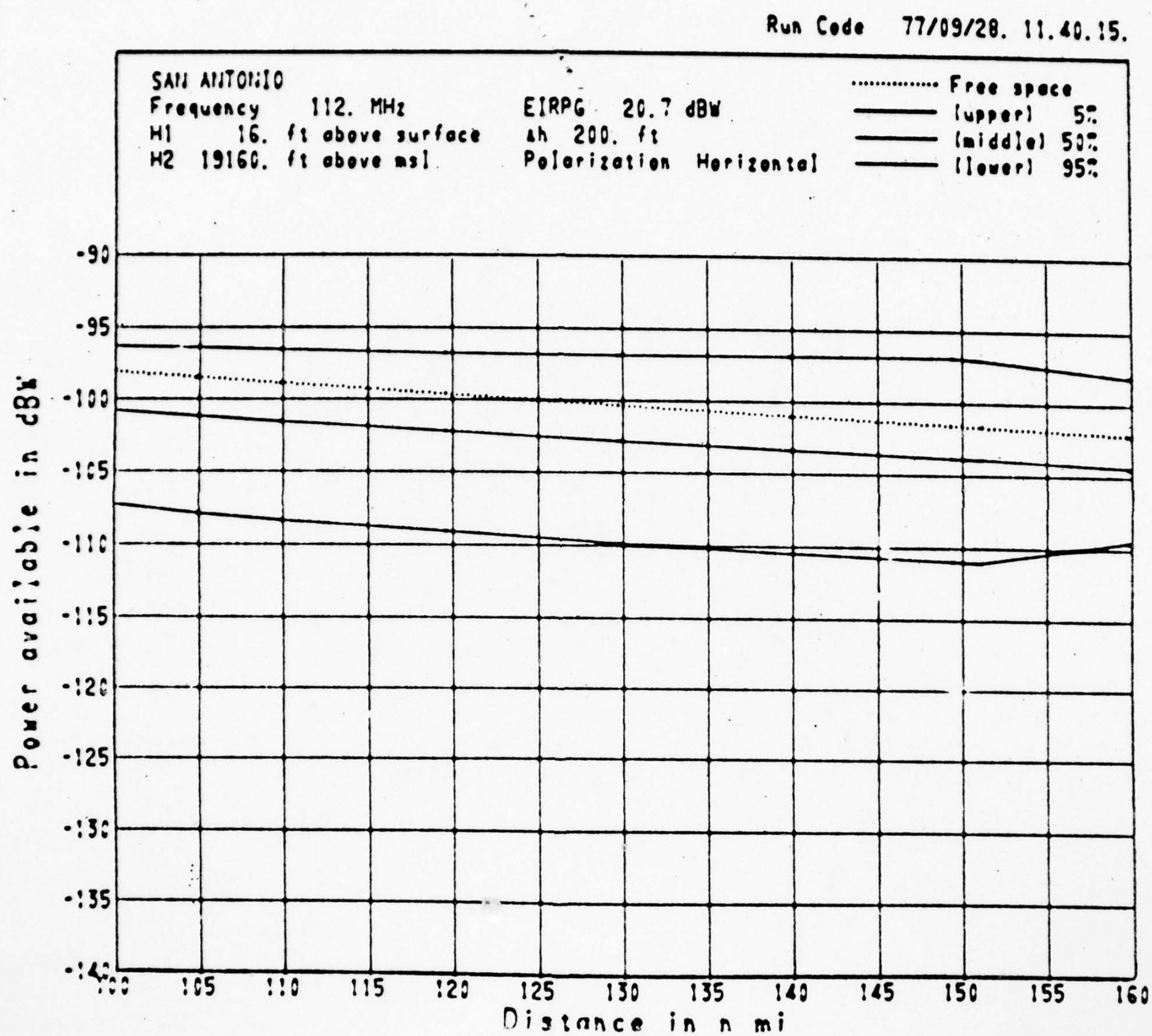

Run Code 77/09/28. 11.40.15.
SAN ANTONIO
Frequency 112. MHz
H1 16. ft above surface
H2 19160. ft above msl
EIRPG 20.7 dBW
Δh 200. ft
Polarization Horizontal
Free space
(upper) 5%
(middle) 50%
(lower) 95%
Power available in dBW
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
100
105
110
115
120
125
130
135
140
145
150
155
160
Distance in n mi

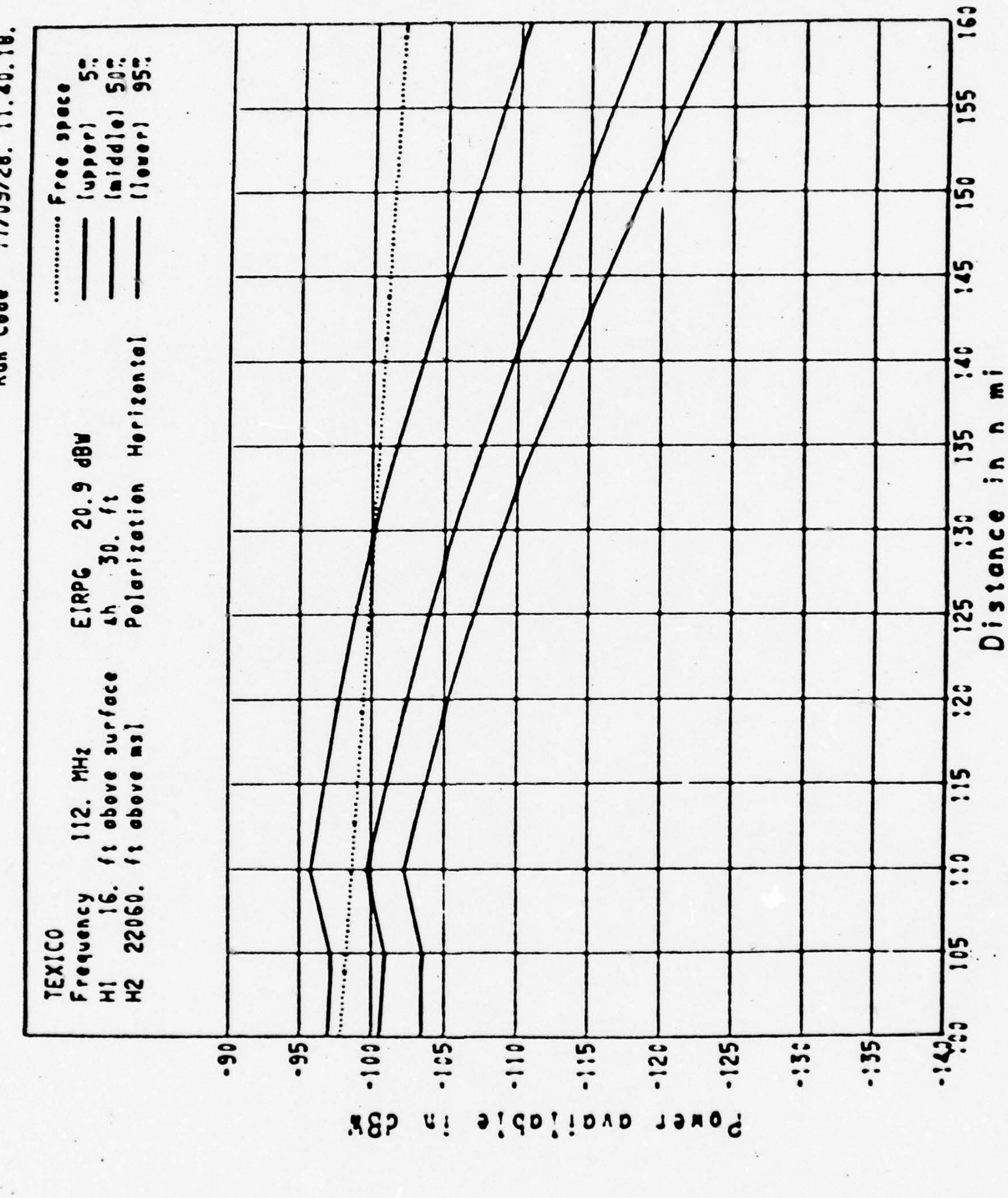
FIGURE I 14

```
                PARAMETERS FOR ITS PROPAGATION MODEL  APR 77
                     77/09/28.   11.40.15. RUN

                    POWER AVAILABLE FOR SAN ANTONIO
                          REQUIRED OR FIXED
                          -----------------
        AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  19160. FT ABOVE MSL
        FACILITY (OR LOWER) ANTENNA HEIGHT:     16.0 FT ABOVE SITE SURFACE
        FREQUENCY:  112. MHZ

                    SPECIFICATION OPTIONAL
                    ----------------------
        AIRCRAFT ANTENNA TYPE:  ISOTROPIC
           POLARIZATION: HORIZONTAL
        EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:   700. FT
        EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   20.7 DBW
        FACILITY ANTENNA TYPE:  4-LOOP ARRAY (COSINE VERTICAL PATTERN)
           POLARIZATION: HORIZONTAL
           COUNTERPOISE DIAMETER:  52. FT
              HEIGHT:  12. FT ABOVE SITE SURFACE
              SURFACE: METALLIC
        HORIZON OBSTACLE DISTANCE:  28.01 N MI FROM FACILITY
           ELEVATION ANGLE:   -0/17/53 DEG/MIN/SEC ABOVE HORIZONTAL*
           HEIGHT:  788. FT ABOVE MSL
        REFRACTIVITY:
           EFFECTIVE EARTH RADIUS: 4665. N MI*
           MINIMUM MONTHLY MEAN: 317. N-UNITS AT SEA LEVEL
        SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
        SURFACE TYPE:  AVERAGE GROUND
        TERRAIN ELEVATION AT SITE: 1144. FT ABOVE MSL
        TERRAIN PARAMETER: 200. FT
        TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


        * COMPUTED VALUE
```



Run Code 77/09/28. 11.40.18.
TEXICO
Frequency 112. MHz
H1 16. ft above surface
H2 22060. ft above msl
EIRPG 20.9 dBW
Δh 30. ft
Polarization Horizontal
Free space
(upper) 5%
(middle) 50%
(lower) 95%
Power available in dBW
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
Distance in n mi
100
105
110
115
120
125
130
135
140
145
150
155
160

FIGURE I 15

```
                    PARAMETERS FOR ITS PROPAGATION MODEL   APR 77
                         77/09/28.    11.40.18. PUN

                         POWER AVAILABLE FOR TEXICO
                          REQUIRED OR FIXED
                          -----------------
        AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  2266.. FT ABOVE MSL
        FACILITY (OR LOWER) ANTENNA HEIGHT:     16.0 FT ABOVE SITE SURFACE
        FREQUENCY:  112. MHZ

                       SPECIFICATION OPTIONAL
                       ----------------------
        AIRCRAFT ANTENNA TYPE:  ISOTROPIC
             POLARIZATION: HORIZONTAL
        EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:  -030. FT
        EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:    20.9 DBW
        FACILITY ANTENNA TYPE:  4-LOOP ARRAY (COSINE VERTICAL PATTERN)
             POLARIZATION: HORIZONTAL
             COUNTERPOISE DIAMETER:  52. FT
                  HEIGHT:  12. FT ABOVE SITE SURFACE
                  SURFACE: METALLIC
        HORIZON OBSTACLE DISTANCE:    6.75 N MI FROM FACILITY
             ELEVATION ANGLE:   -0/ 3/22 DEG/MIN/SEC ABOVE HORIZONTAL*
             HEIGHT: -100. FT ABOVE MSL
        REFRACTIVITY:
             EFFECTIVE EARTH RADIUS: 4288. N MI*
             MINIMUM MONTHLY MEAN: 295. N-UNITS AT SEA LEVEL
        SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
        SURFACE TYPE:  AVERAGE GROUND
        TERRAIN ELEVATION AT SITE: 4082. FT ABOVE MSL
        TERRAIN PARAMETER:  30. FT
        TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


        * COMPUTED VALUE
```


242

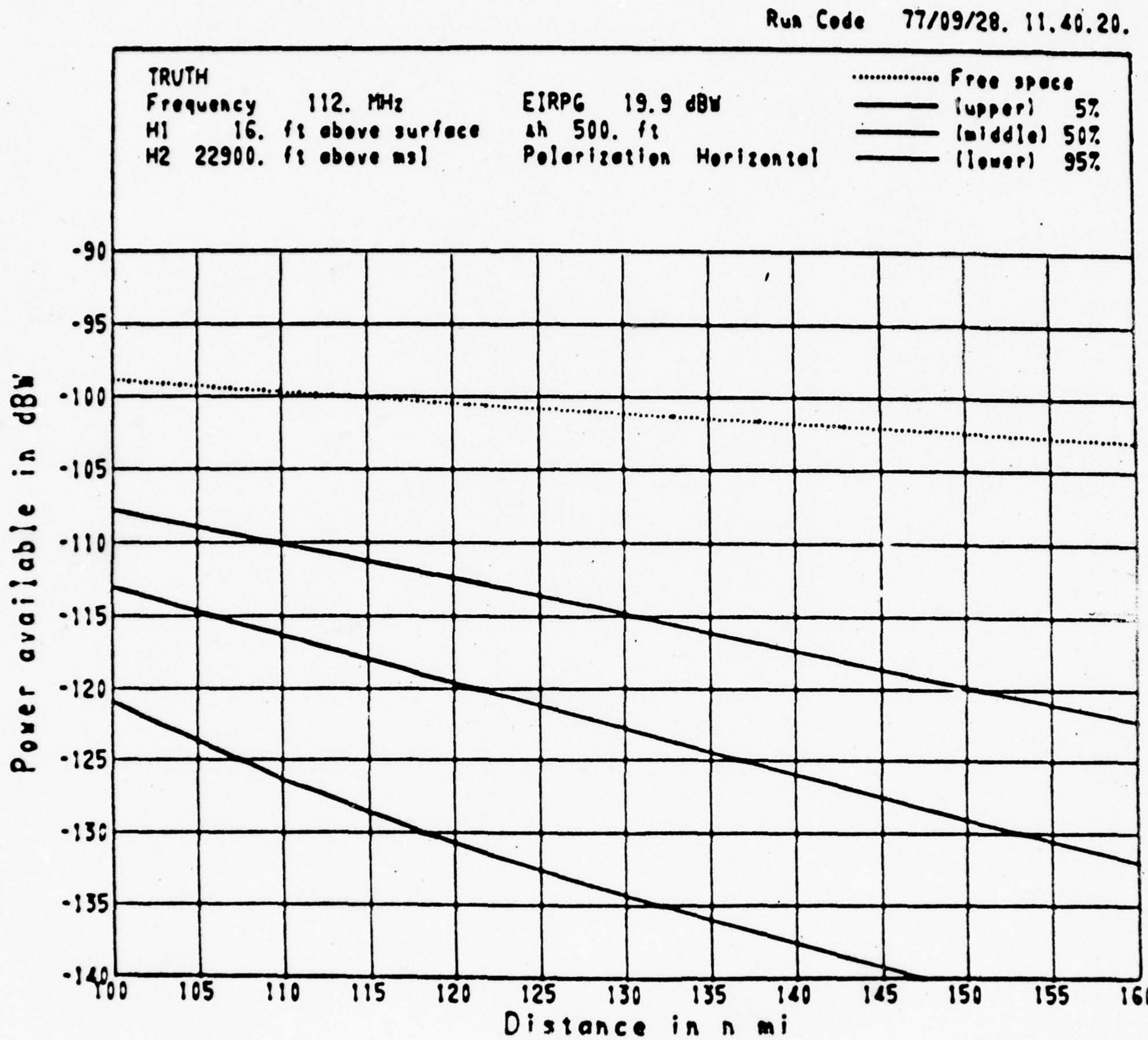

Run Code 77/09/28. 11.40.20.
TRUTH
Frequency 112. MHz
H1 16. ft above surface
H2 22900. ft above msl
EIRPG 19.9 dBW
Δh 500. ft
Polarization Horizontal
Free space
(upper) 5%
(middle) 50%
(lower) 95%
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
100
105
110
115
120
125
130
135
140
145
150
155
160
Power available in dBW
Distance in n mi

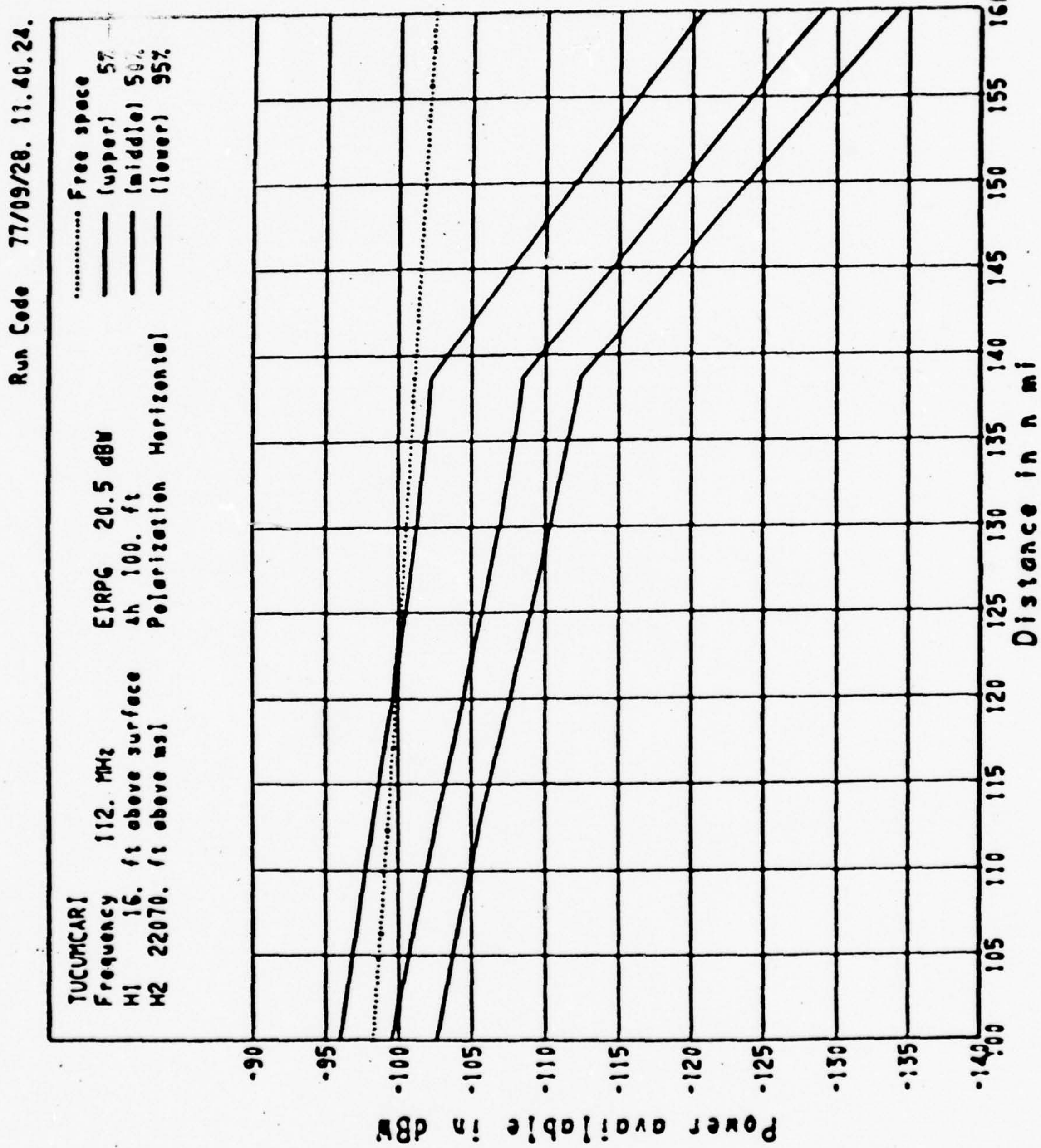
FIGURE I 16

```
                    PARAMETERS FOR ITS PROPAGATION MODEL  APR 77
                              77/09/28.   11.40.20. RUN

                         POWER AVAILABLE FOR TRUTH
                         REQUIRED OR FIXED
                         -----------------
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  22900. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:      16.0 FT ABOVE SITE SURFACE
FREQUENCY:  112. MHZ

                    SPECIFICATION OPTIONAL
                    ----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: HORIZONTAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:  4800. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   19.9 DBW
FACILITY ANTENNA TYPE:  4-LOOP ARRAY (COSINE VERTICAL PATTERN)
     POLARIZATION: HORIZONTAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:    9.50 N MI FROM FACILITY
     ELEVATION ANGLE:    1/ 6/36 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT: 6102. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4251. N MI*
     MINIMUM MONTHLY MEAN: 295. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 4903  FT ABOVE MSL
TERRAIN PARAMETER: 500. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


* COMPUTED VALUE
```


Run Code 77/09/28. 11.40.24.
TUCUMCARI
Frequency 112. MHz
H1 16. ft above surface
H2 22070. ft above msl
EIRPG 20.5 dBW
Δh 100. ft
Polarization Horizontal
Free space
(upper) 5%
(middle) 50%
(lower) 95%
Power available in dBW
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
100
105
110
115
120
125
130
135
140
145
150
155
160
Distance in n mi
FIGURE I 17

```
              PARAMETERS FOR ITS PROPAGATION MODEL  APR 77
                        77/09/28.    11.40.24. RUN

                     POWER AVAILABLE FOR TUCUMCARI
                         REQUIRED OR FIXED
                         -----------------
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  22070. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:      16.0 FT ABOVE SITE SURFACE
FREQUENCY:  112. MHZ

                      SPECIFICATION OPTIONAL
                      ----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: HORIZONTAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:  4000. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:    20.5 DBW
FACILITY ANTENNA TYPE:  4-LOOP ARRAY (COSINE VERTICAL PATTERN)
     POLARIZATION: HORIZONTAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:  12.50 N MI FROM FACILITY
     ELEVATION ANGLE:    0/ 1/54 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT: 4201. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4279. N MI*
     MINIMUM MONTHLY MEAN: 293. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 4032. FT ABOVE MSL
TERRAIN PARAMETER: 100. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


* COMPUTED VALUE
```

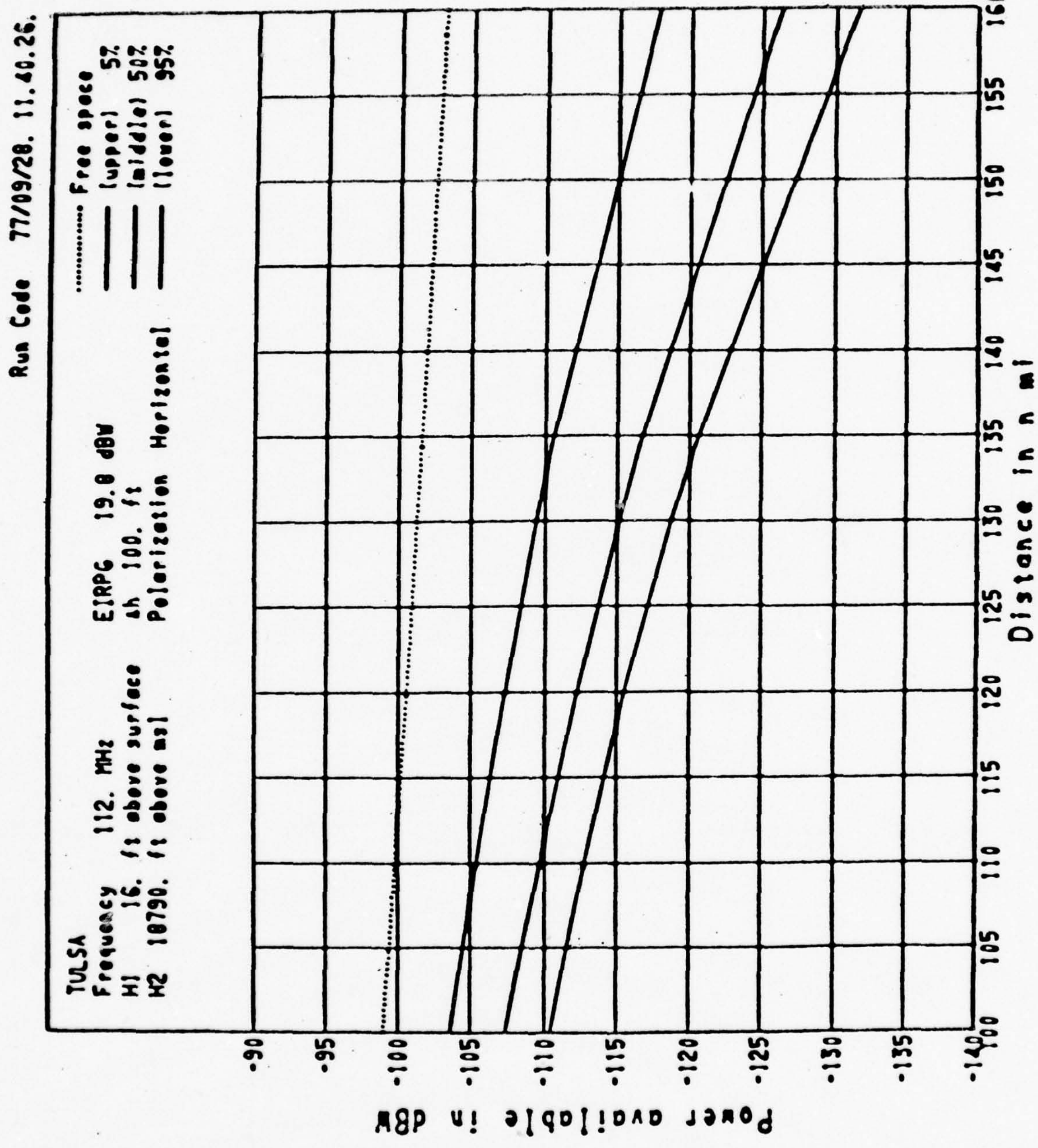


FIGURE I 18

247

```
            PARAMETERS FOR ITS PROPAGATION MODEL   APR 77
                     77/09/28.   11.40.26. RUN

                  POWER AVAILABLE FOR TULSA
                  REQUIRED OR FIXED
                  -----------------
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  18790. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:      16.0 FT ABOVE SITE SURFACE
FREQUENCY:  112. MHZ

                SPECIFICATION OPTIONAL
                ----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: HORIZONTAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:   780. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:    19.8 DBW
FACILITY ANTENNA TYPE:  4-LOOP ARRAY (COSINE VERTICAL PATTERN)
     POLARIZATION: HORIZONTAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:    5.75 N MI FROM FACILITY
     ELEVATION ANGLE:   -0/ 2/50 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT:  791. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4597. N MI*
     MINIMUM MONTHLY MEAN: 310. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE:  782. FT ABOVE MSL
TERRAIN PARAMETER: 100. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


* COMPUTED VALUE
```


248

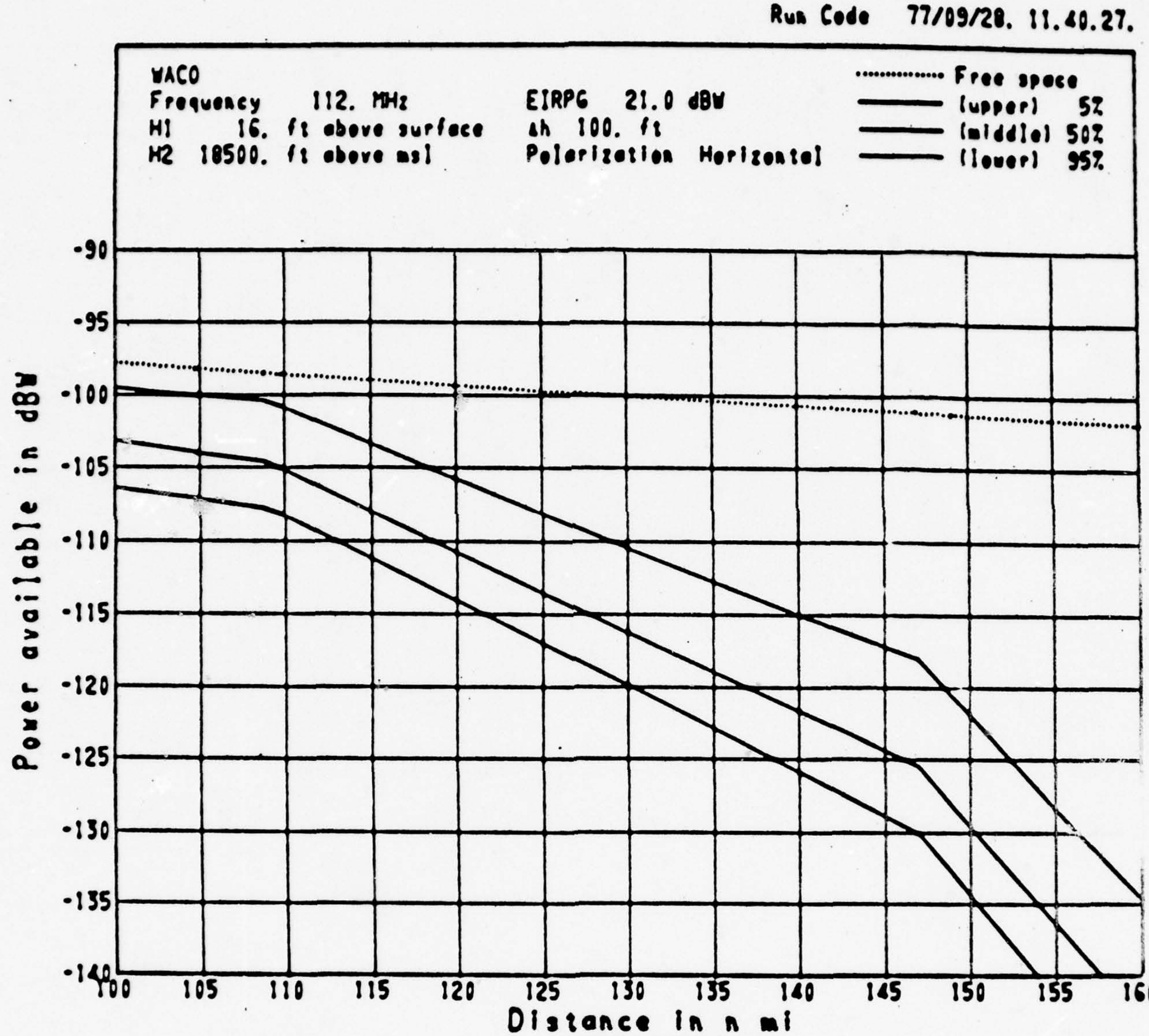

Run Code 77/09/28. 11.40.27.
WACO
Frequency 112. MHz
H1 16. ft above surface
H2 18500. ft above msl
EIRPG 21.0 dBW
Δh 100. ft
Polarization Horizontal
Free space
(upper) 5%
(middle) 50%
(lower) 95%
Power available in dBW
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
100
105
110
115
120
125
130
135
140
145
150
155
160
Distance in n mi

FIGURE I 19

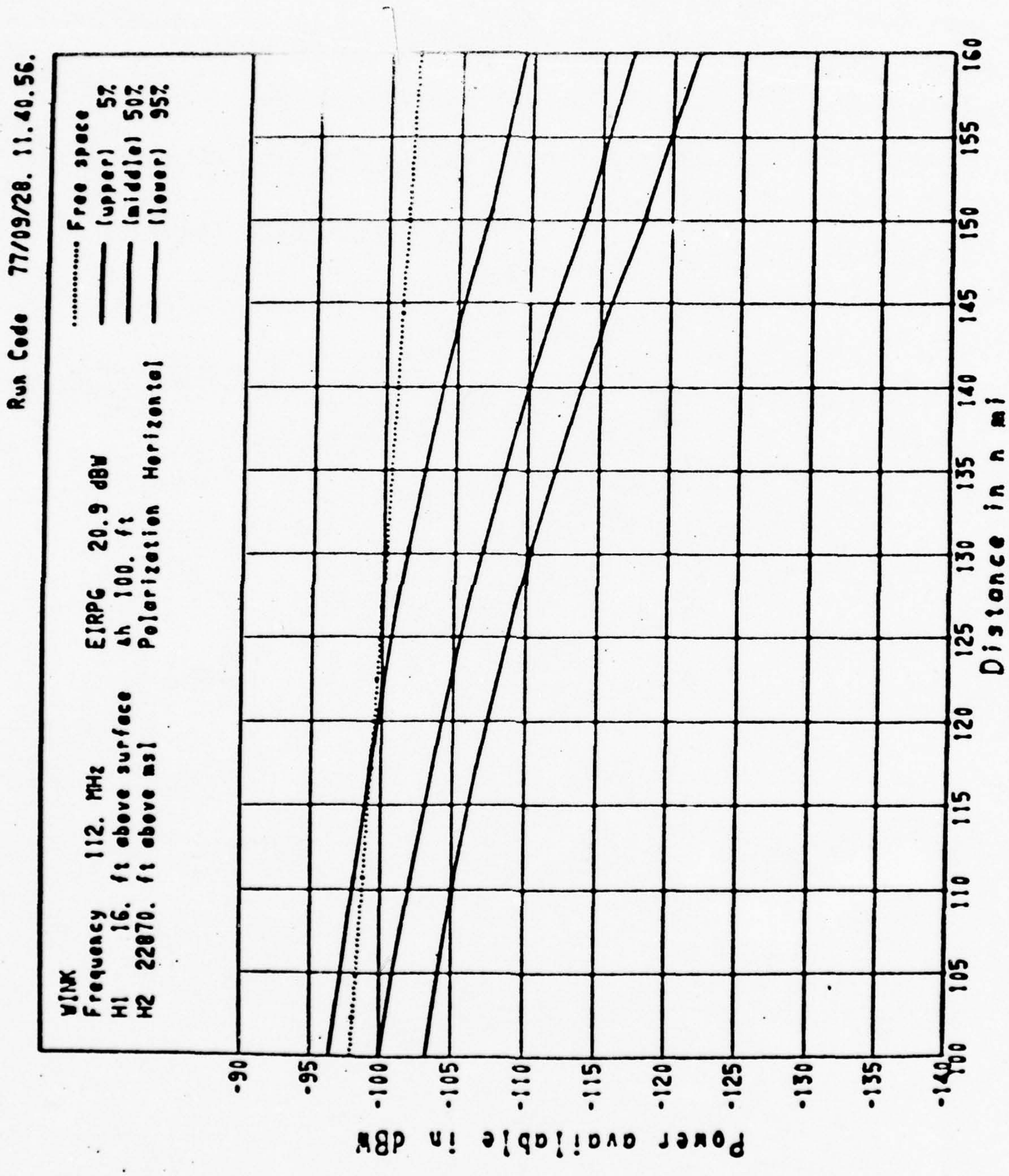
```
        PARAMETERS FOR ITS PROPAGATION MODEL   APR 77
                  77/09/28.    11.40.27. RUN

                  POWER AVAILABLE FOR WACO
                  REQUIRED OR FIXED
                  -----------------
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  18500. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:      16.0 FT ABOVE SITE SURFACE
FREQUENCY:  112. MHZ

               SPECIFICATION OPTIONAL
               ----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: HORIZONTAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:   500. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   21.0 DBW
FACILITY ANTENNA TYPE:  4-LOOP ARRAY (COSINE VERTICAL PATTERN)
     POLARIZATION: HORIZONTAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:   1.75 N MI FROM FACILITY
     ELEVATION ANGLE:    0/13/15 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT:  559. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4639. N MI*
     MINIMUM MONTHLY MEAN: 312. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE:  500. FT ABOVE MSL
TERRAIN PARAMETER: 100. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED

* COMPUTED VALUE
```


250



Run Code 77/09/28. 11.40.56.
WINK
Frequency 112. MHz
H1 16. ft above surface
H2 22870. ft above msl
EIRPG 20.9 dBW
Δh 100. ft
Polarization Horizontal
Free space
(upper) 5%
(middle) 50%
(lower) 95%
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
Power available in dBW
100
105
110
115
120
125
130
135
140
145
150
155
160
Distance in n mi

FIGURE I 20

```
              PARAMETERS FOR ITS PROPAGATION MODEL  APR'77
                          77/09/28.   11.40.56. RUN

                   POWER AVAILABLE FOR WINK
                   REQUIRED OR FIXED
                   -----------------
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  22378. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:     16.0 FT ABOVE SITE SURFACE
FREQUENCY:  112. MHZ

                 SPECIFICATION OPTIONAL
                 ----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: HORIZONTAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:  2819. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   20.9 DBW
FACILITY ANTENNA TYPE:  4-LOOP ARRAY (COSINE VERTICAL PATTERN)
     POLARIZATION: HORIZONTAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:   6.50 N MI FROM FACILITY
     ELEVATION ANGLE:   -0/ 6/23 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT: 2819. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4351. N MI*
     MINIMUM MONTHLY MEAN: 295. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 2847. FT ABOVE MSL
TERRAIN PARAMETER: 100. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


* COMPUTED VALUE
```

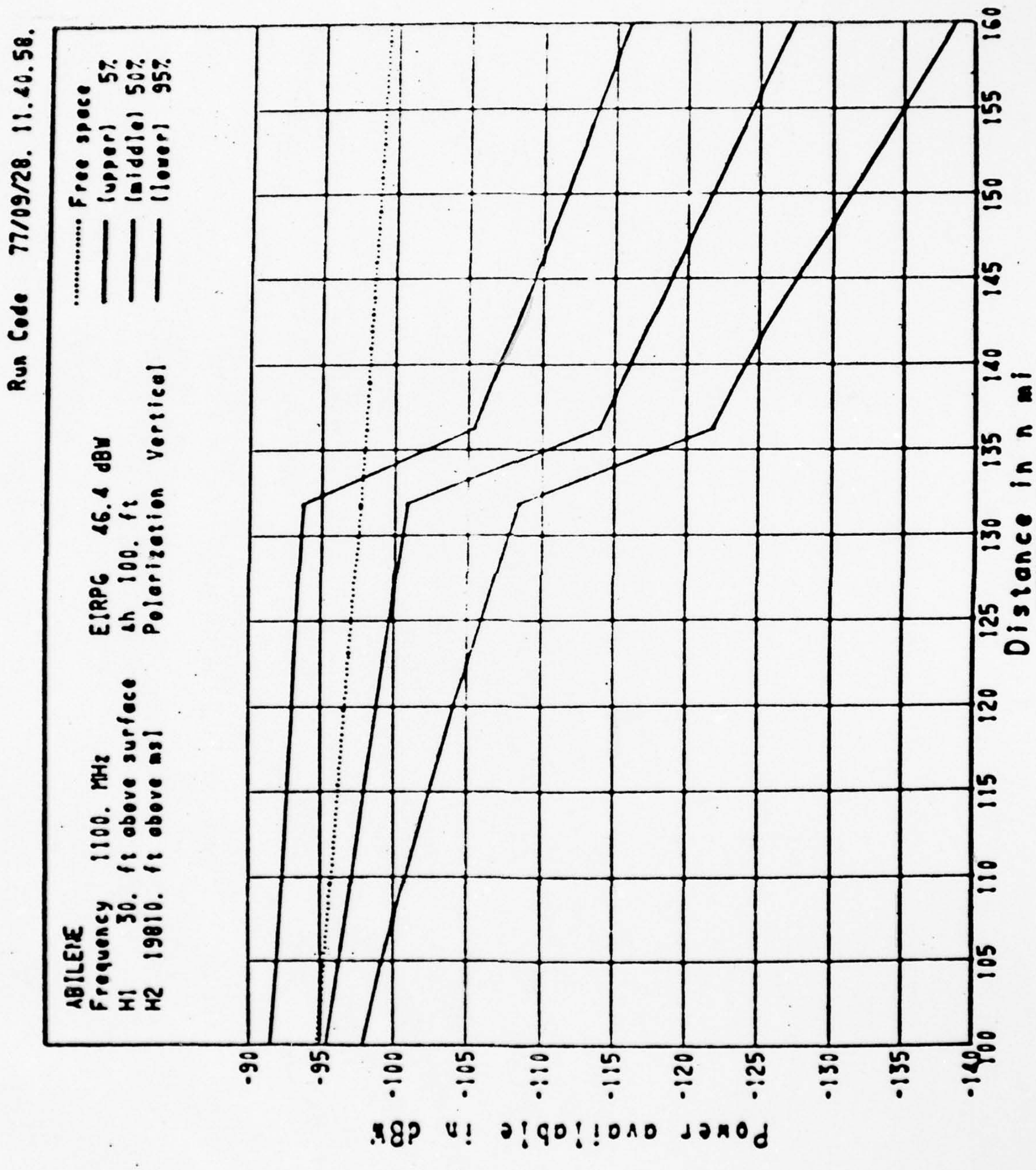

Run Code 77/09/28. 11.40.58.
ABILENE
Frequency 1100. MHz
H1 30. ft above surface
H2 19810. ft above msl
EIRPG 46.4 dBW
Δh 100. ft
Polarization Vertical
Free space
(upper) 5%
(middle) 50%
(lower) 95%
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
Power available in dBW
100
105
110
115
120
125
130
135
140
145
150
155
160
Distance in n mi

FIGURE I 21

PARAMETERS FOR ITS PROPAGATION MODEL APR 77
77/09/28. 11.40.58. RUN

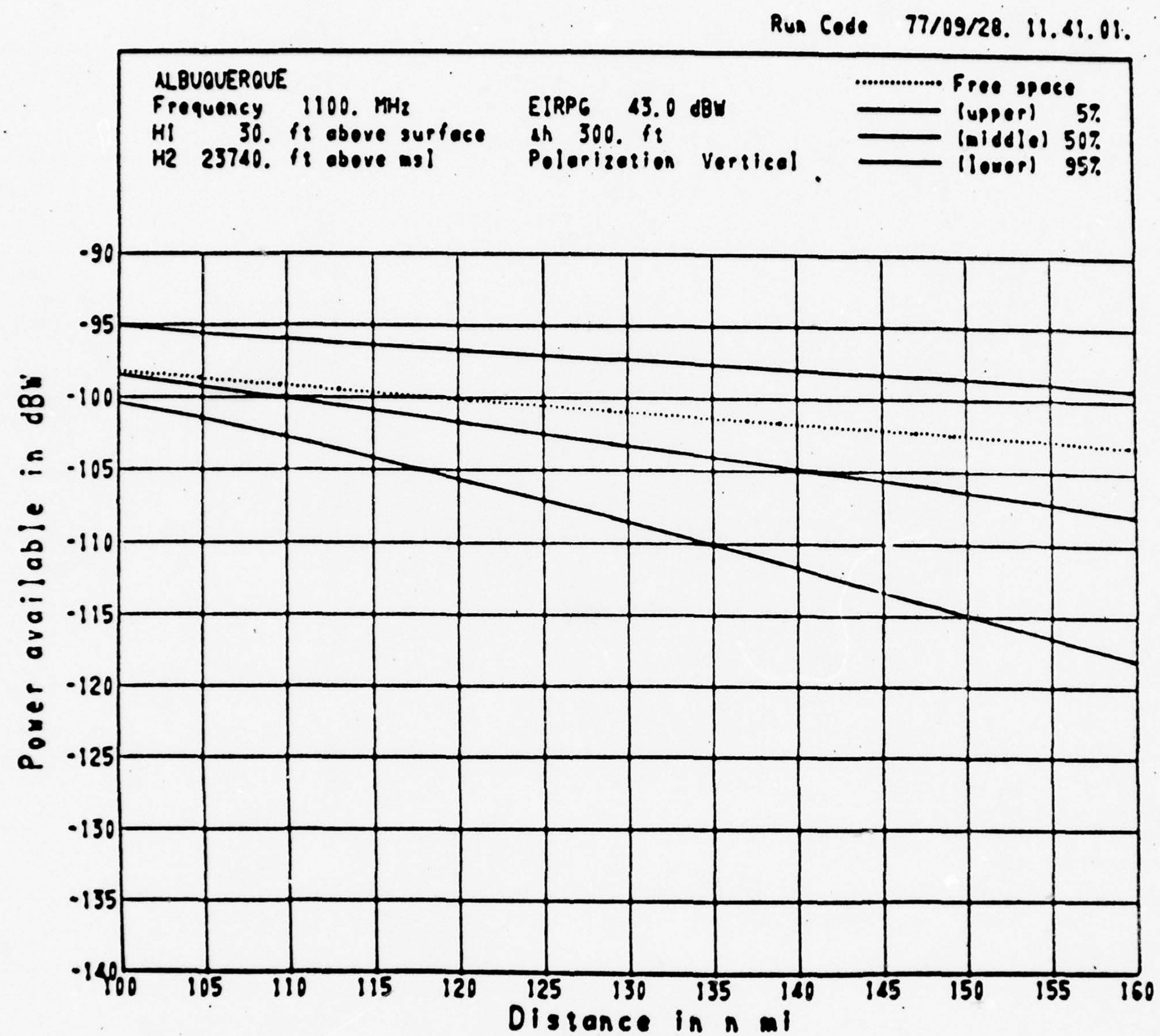
POWER AVAILABLE FOR ABILENE
REQUIRED OR FIXED

```
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  19810. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:     30.0 FT ABOVE SITE SURFACE
FREQUENCY: 1100. MHZ
```

SPECIFICATION OPTIONAL

```
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: VERTICAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:  1600. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   46.4 DBW
FACILITY ANTENNA TYPE:  TACAN (RTA-2)
     POLARIZATION: VERTICAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:  12.25 N MI FROM FACILITY
     ELEVATION ANGLE:    0/20/50 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT: 2390. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4480. N MI*
     MINIMUM MONTHLY MEAN: 305. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 1867. FT ABOVE MSL
TERRAIN PARAMETER: 100. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED
```

* COMPUTED VALUE



Run Code 77/09/28. 11.41.01.
ALBUQUERQUE
Frequency 1100. MHz
H1 30. ft above surface
H2 23740. ft above msl
EIRPG 43.0 dBW
Δh 300. ft
Polarization Vertical
Free space
(upper) 5%
(middle) 50%
(lower) 95%
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
100
105
110
115
120
125
130
135
140
145
150
155
160
Power available in dBW
Distance in n mi

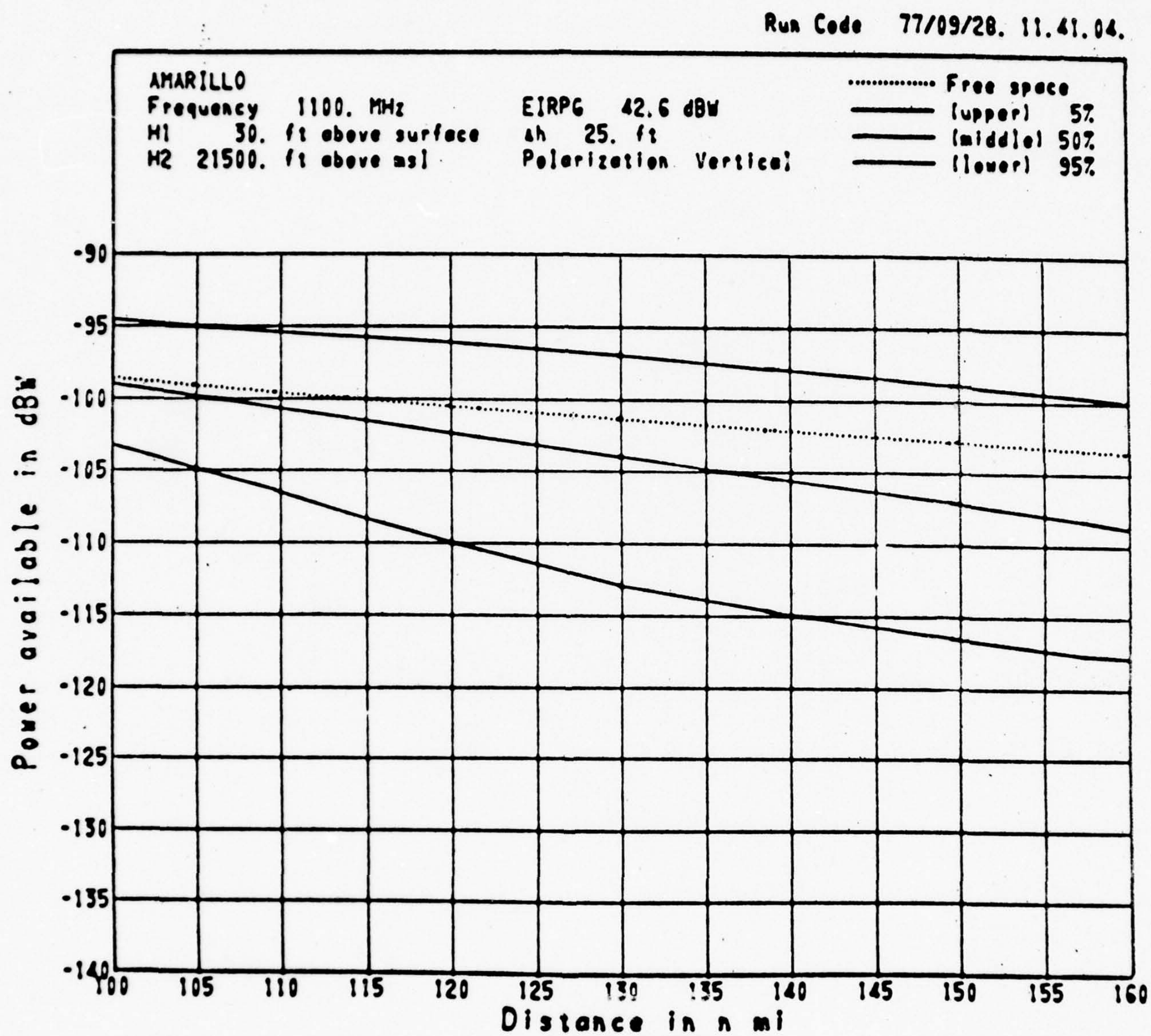
FIGURE I 22

```
PAGE    1  77/09/28.  11.41.01.
                PARAMETERS FOR ITS PROPAGATION MODEL   APR 77
                          77/09/28.    11.41.01. RUN

                   POWER AVAILABLE FOR ALBUQUERQUE
                      REQUIRED OR FIXED
                      -----------------
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  23740. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:      30.0 FT ABOVE SITE SURFACE
FREQUENCY: 1100. MHZ

              SPECIFICATION OPTIONAL
              ----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: VERTICAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:  5471. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:    43.0 DBW
FACILITY ANTENNA TYPE:  TACAN (RTA-2)
     POLARIZATION: VERTICAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:  14.76 N MI FROM FACILITY
     ELEVATION ANGLE:   -0/17/10 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT: 5471. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4209. N MI*
     MINIMUM MONTHLY MEAN: 292. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 5732. FT ABOVE MSL
TERRAIN PARAMETER: 300. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


* COMPUTED VALUE
```



Run Code 77/09/28. 11.41.04.
AMARILLO
Frequency 1100. MHz
H1 30. ft above surface
H2 21500. ft above msl
EIRPG 42.6 dBW
Δh 25. ft
Polarization Vertical
Free space
(upper) 5%
(middle) 50%
(lower) 95%
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
100
105
110
115
120
125
130
135
140
145
150
155
160
Power available in dBW
Distance in n mi

FIGURE I 23

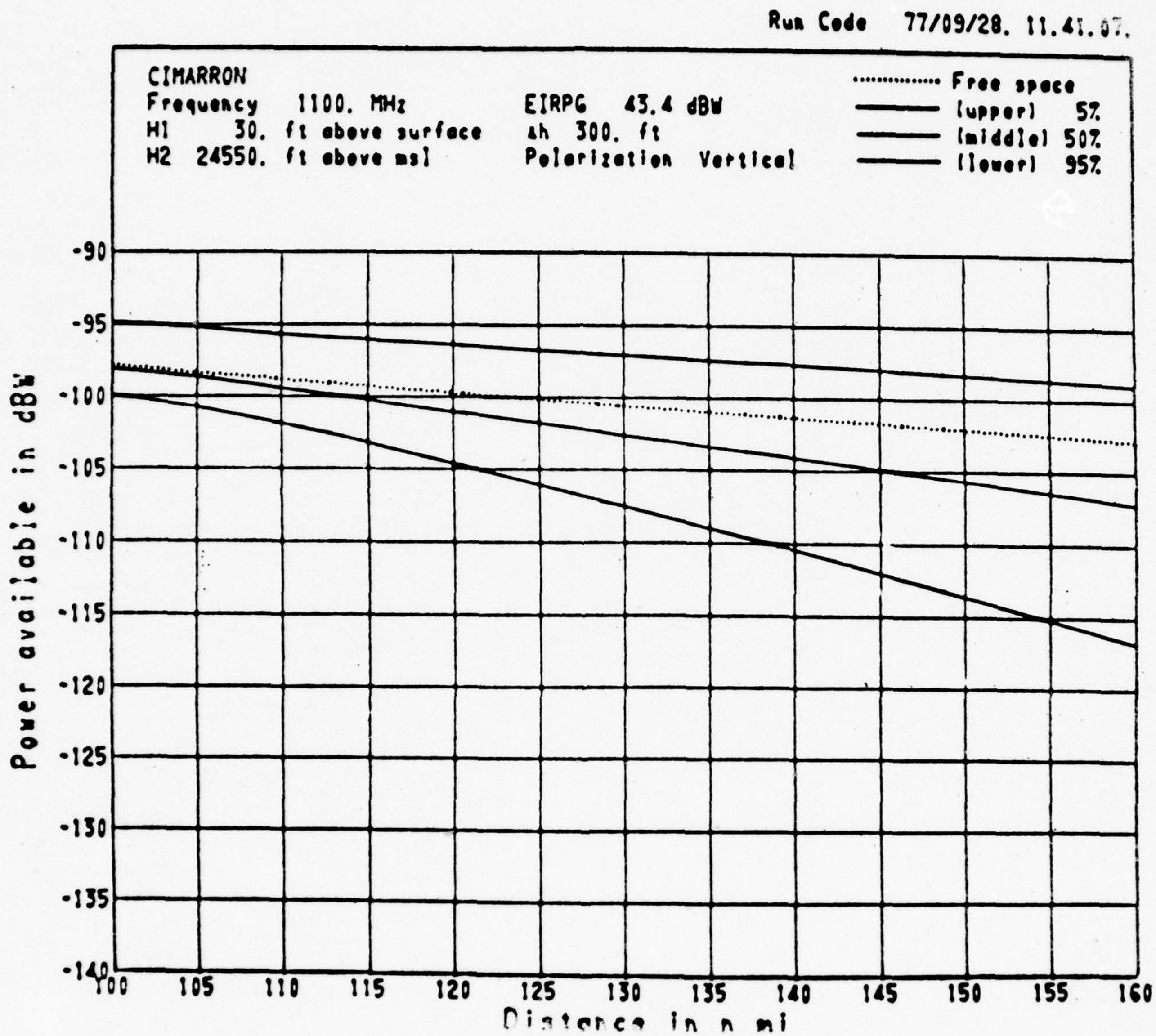
PARAMETERS FOR ITS PROPAGATION MODEL APR 77
77/09/28. 11.41.04. RUN

POWER AVAILABLE FOR AMARILLO
REQUIRED OR FIXED

```
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  21500. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:     30.0 FT ABOVE SITE SURFACE
FREQUENCY: 1100. MHZ

                SPECIFICATION OPTIONAL
                ----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: VERTICAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:  3440. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   +2.6 DBW
FACILITY ANTENNA TYPE:  TACAN (RTA-2)
     POLARIZATION: VERTICAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:  12.50 N MI FROM FACILITY
     ELEVATION ANGLE:   -0/11/17 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT: 3440. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4335. N MI*
     MINIMUM MONTHLY MEAN: 298. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 3550. FT ABOVE MSL
TERRAIN PARAMETER:  25. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED
```

* COMPUTED VALUE



Run Code 77/09/28. 11.41.07.
CIMARRON
Frequency 1100. MHz
H1 30. ft above surface
H2 24550. ft above msl
EIRPG 43.4 dBW
Δh 300. ft
Polarization Vertical
Free space
(upper) 5%
(middle) 50%
(lower) 95%
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
100
105
110
115
120
125
130
135
140
145
150
155
160
Power available in dBW
Distance in n mi

FIGURE I 24

PARAMETERS FOR ITS PROPAGATION MODEL APR 77
77/09/28. 11.41.07. RUN

POWER AVAILABLE FOR CIMARRON
REQUIRED OR FIXED

AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE: 24550. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT: 30.0 FT ABOVE SITE SURFACE
FREQUENCY: 1100. MHZ

SPECIFICATION OPTIONAL

AIRCRAFT ANTENNA TYPE: ISOTROPIC
POLARIZATION: VERTICAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL: 6100. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN: 43.4 DBW
FACILITY ANTENNA TYPE: TACAN (RTA-2)
POLARIZATION: VERTICAL
COUNTERPOISE DIAMETER: 52. FT
HEIGHT: 12. FT ABOVE SITE SURFACE
SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE: 35.51 N MI FROM FACILITY
ELEVATION ANGLE: -0/19/55 DEG/MIN/SEC ABOVE HORIZONTAL*
HEIGHT: 6239. FT ABOVE MSL
REFRACTIVITY:
EFFECTIVE EARTH RADIUS: 4137. N MI*
MINIMUM MONTHLY MEAN: 293. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING: CONTRIBUTES TO VARIABILITY
SURFACE TYPE: AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 6545. FT ABOVE MSL
TERRAIN PARAMETER: 300. FT
TIME AVAILABILITY: FOR INSTANTANEOUS LEVELS EXCEEDED

* COMPUTED VALUE

I 50

260

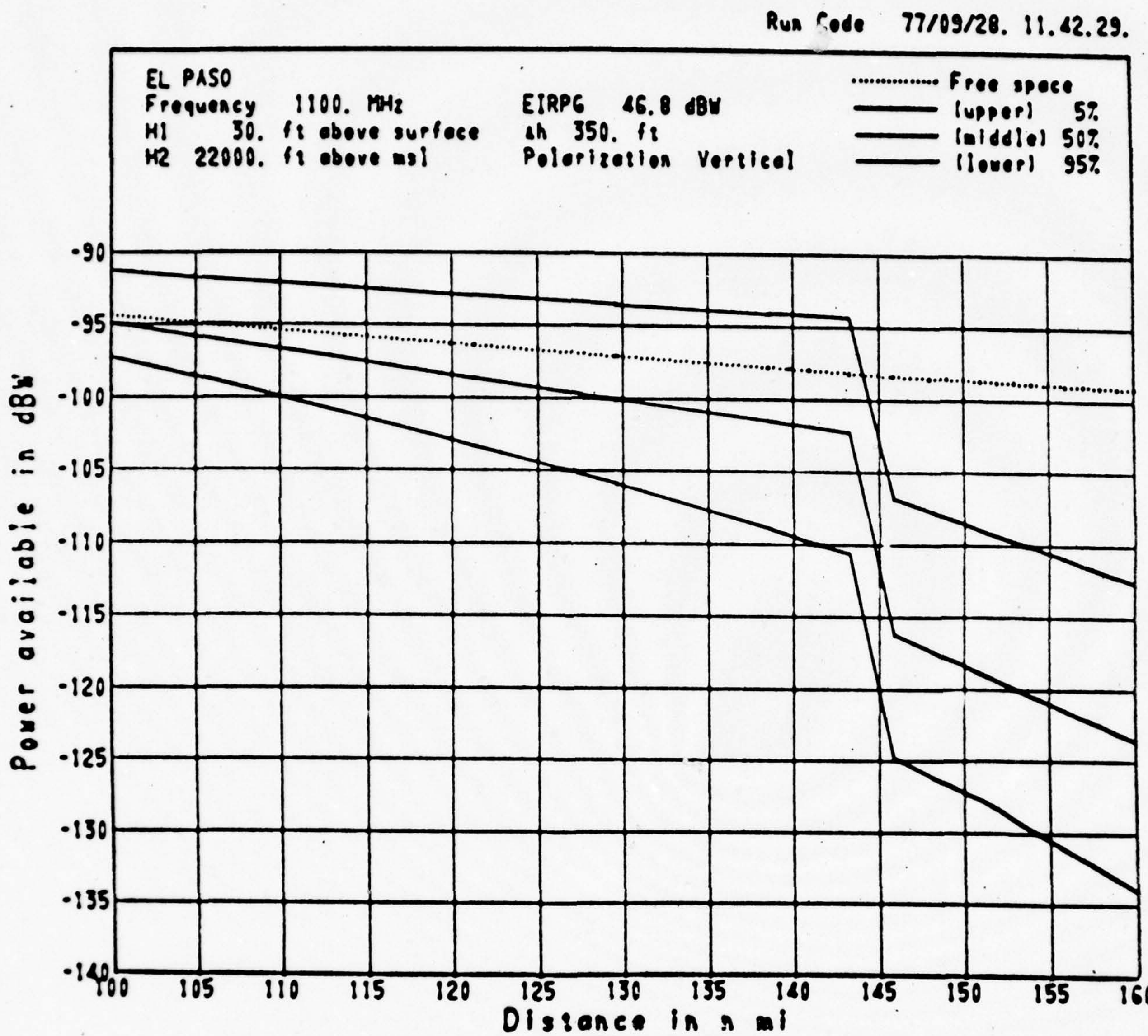

Run Code 77/09/28. 11.42.29.
EL PASO
Frequency 1100. MHz
H1 30. ft above surface
H2 22000. ft above msl
EIRPG 46.8 dBW
Δh 350. ft
Polarization Vertical
Free space
(upper) 5%
(middle) 50%
(lower) 95%
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
Power available in dBW
100
105
110
115
120
125
130
135
140
145
150
155
160
Distance in n mi

FIGURE I 25

```
                PARAMETERS FOR ITS PROPAGATION MODEL  APR 77
                      77/09/28.   11.42.29. RUN

                   POWER AVAILABLE FOR EL PASO
                    REQUIRED OR FIXED
                    -----------------
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  22000. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:     30.0 FT ABOVE SITE SURFACE
FREQUENCY: 1100. MHZ

                  SPECIFICATION OPTIONAL
                  ----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
    POLARIZATION: VERTICAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:  4000. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:    46.8 DBW
FACILITY ANTENNA TYPE:  TACAN (RTA-2)
    POLARIZATION: VERTICAL
    COUNTERPOISE DIAMETER:  52. FT
        HEIGHT:  12. FT ABOVE SITE SURFACE
        SURFACE: METALLIC
    DLT IS LESS THAN .1XDLST OR GREATER THAN 3XDLST
HORIZON OBSTACLE DISTANCE:  30.01 N MI FROM FACILITY
    ELEVATION ANGLE:    0/ 9/46 DEG/MIN/SEC ABOVE HORIZONTAL*
    HEIGHT: 5206. FT ABOVE MSL
REFRACTIVITY:
    EFFECTIVE EARTH RADIUS: 4279. N MI*
    MINIMUM MONTHLY MEAN: 293. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 4020. FT ABOVE MSL
TERRAIN PARAMETER: 350. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


* COMPUTED VALUE
```

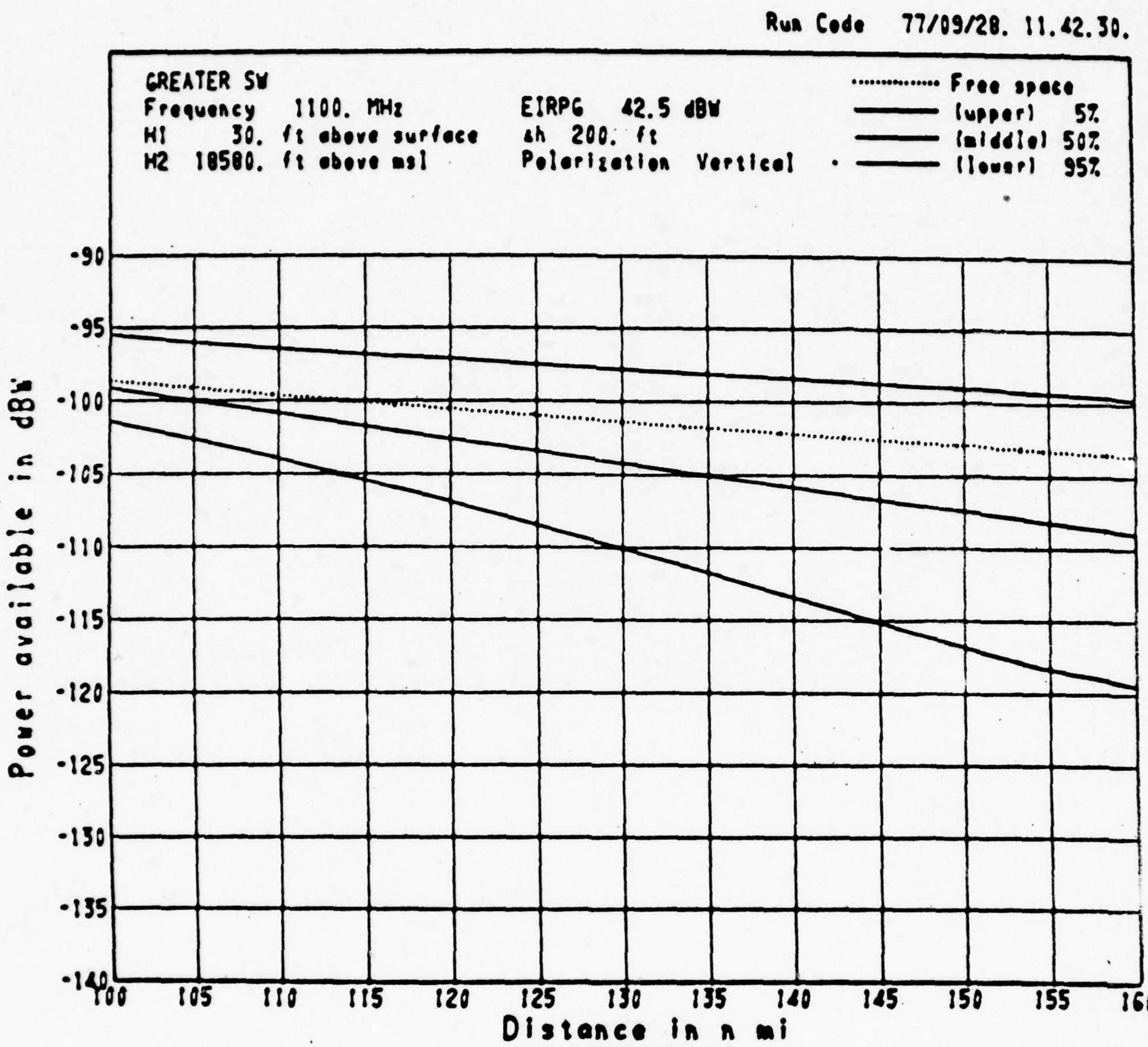

Run Code 77/09/28. 11.42.30.
GREATER SW
Frequency 1100. MHz
H1 30. ft above surface
H2 10500. ft above msl
EIRPG 42.5 dBW
Δh 200. ft
Polarization Vertical
Free space
(upper) 5%
(middle) 50%
(lower) 95%
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
100
105
110
115
120
125
130
135
140
145
150
155
160
Power available in dBW
Distance in n mi

FIGURE I 26

```
                PARAMETERS FOR ITS PROPAGATION MODEL   APR 77
                          77/09/28.    11.42.30. RUN

                      POWER AVAILABLE FOR GREATER SW
                         REQUIRED OR FIXED
                         -----------------
        AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  18580. FT ABOVE MSL
        FACILITY (OR LOWER) ANTENNA HEIGHT:     30.0 FT ABOVE SITE SURFACE
        FREQUENCY: 1100. MHZ

                      SPECIFICATION OPTIONAL
                      ----------------------
        AIRCRAFT ANTENNA TYPE:  ISOTROPIC
             POLARIZATION: VERTICAL
        EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:   500. FT
        EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:    42.5 DBW
        FACILITY ANTENNA TYPE:  TACAN (RTA-2)
             POLARIZATION: VERTICAL
             COUNTERPOISE DIAMETER:  52. FT
                  HEIGHT:  12. FT ABOVE SITE SURFACE
                  SURFACE: METALLIC
        HORIZON OBSTACLE DISTANCE:  23.25 N MI FROM FACILITY
             ELEVATION ANGLE:   -0/ 1/45 DEG/MIN/SEC ABOVE HORIZONTAL*
             HEIGHT:  855. FT ABOVE MSL
        REFRACTIVITY:
             EFFECTIVE EARTH RADIUS: 4666. N MI*
             MINIMUM MONTHLY MEAN: 315. N-UNITS AT SEA LEVEL
        SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
        SURFACE TYPE:  AVERAGE GROUND
        TERRAIN ELEVATION AT SITE:  545. FT ABOVE MSL
        TERRAIN PARAMETER: 200. FT
        TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


        * COMPUTED VALUE
```


264

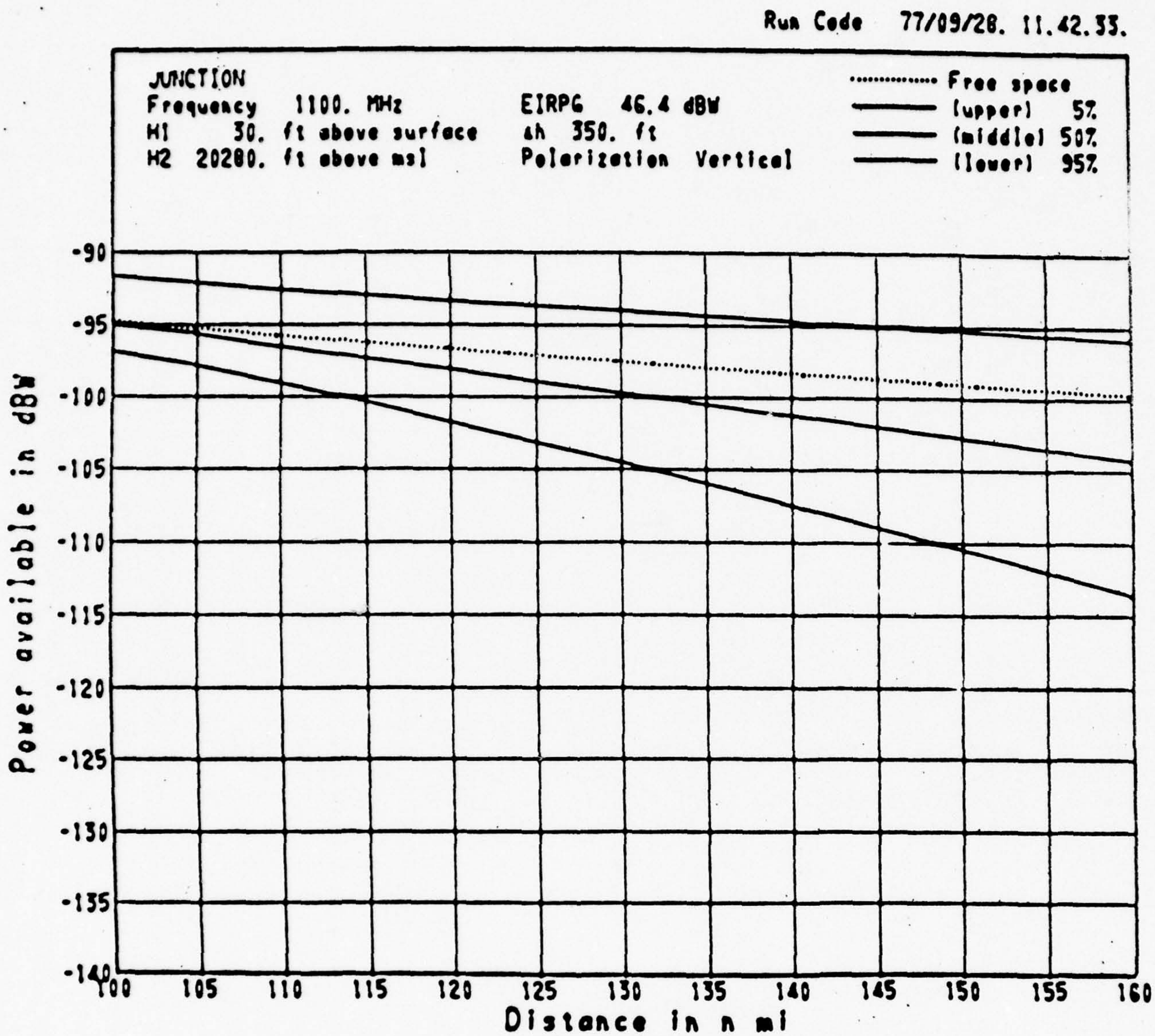

Run Code 77/09/28. 11.42.33.
JUNCTION
Frequency 1100. MHz
H1 30. ft above surface
H2 20280. ft above msl
EIRPG 46.4 dBW
Δh 350. ft
Polarization Vertical
Free space
(upper) 5%
(middle) 50%
(lower) 95%
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
100
105
110
115
120
125
130
135
140
145
150
155
160
Power available in dBW
Distance in n mi

FIGURE I 27

PARAMETERS FOR ITS PROPAGATION MODEL APR 77
77/09/28. 11.42.33. RUN

POWER AVAILABLE FOR JUNCTION
REQUIRED OR FIXED

AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE: 20280. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT: 30.0 FT ABOVE SITE SURFACE
FREQUENCY: 1100. MHZ

SPECIFICATION OPTIONAL

AIRCRAFT ANTENNA TYPE: ISOTROPIC
POLARIZATION: VERTICAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL: 1900. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN: 46.4 DBW
FACILITY ANTENNA TYPE: TACAN (RTA-2)
POLARIZATION: VERTICAL
COUNTERPOISE DIAMETER: 52. FT
HEIGHT: 12. FT ABOVE SITE SURFACE
SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE: 24.08 N MI FROM FACILITY
ELEVATION ANGLE: -0/10/56 DEG/MIN/SEC ABOVE HORIZONTAL*
HEIGHT: 2195. FT ABOVE MSL
REFRACTIVITY:
EFFECTIVE EARTH RADIUS: 4437. N MI*
MINIMUM MONTHLY MEAN: 307. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING: CONTRIBUTES TO VARIABILITY
SURFACE TYPE: AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 2238. FT ABOVE MSL
TERRAIN PARAMETER: 350. FT
TIME AVAILABILITY: FOR INSTANTANEOUS LEVELS EXCEEDED

* COMPUTED VALUE

Run Code 77/09/28. 11.42.38.

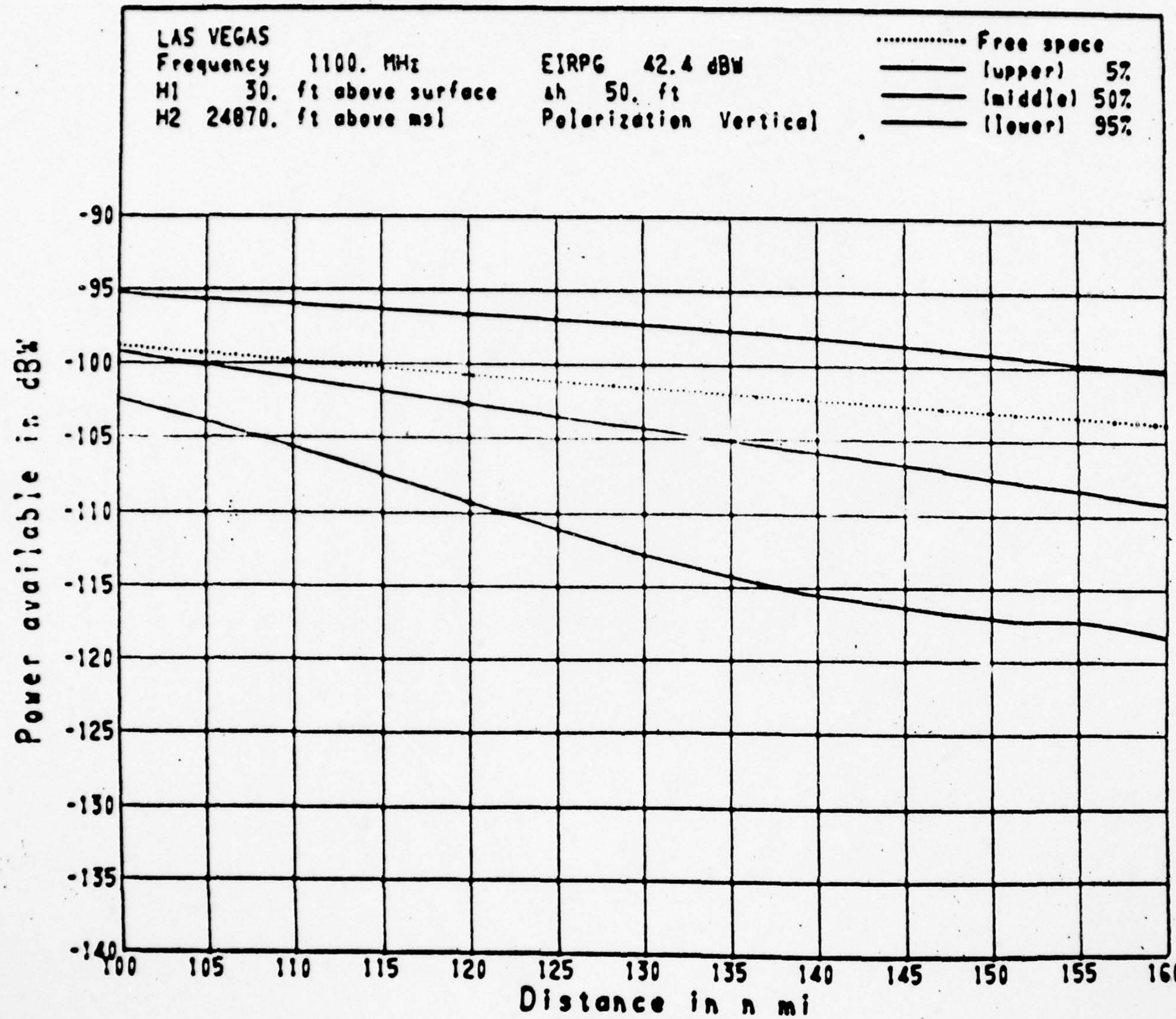


FIGURE I 28

267

```
              PARAMETERS FOR ITS PROPAGATION MODEL  APR 77
                    77/09/28.   11.42.38. RUN

                   POWER AVAILABLE FOR LAS VEGAS
                       REQUIRED OR FIXED
                       -----------------
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  24870. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:     32.0 FT ABOVE SITE SURFACE
FREQUENCY: 1100. MHZ

                   SPECIFICATION OPTIONAL
                   ----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: VERTICAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:  6790. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   +2.4 DBW
FACILITY ANTENNA TYPE:  TACAN (RTA-2)
     POLARIZATION: VERTICAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:  10.94 N MI FROM FACILITY
     ELEVATION ANGLE:   -0/ 4/31 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT: 6900. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4161. N MI*
     MINIMUM MONTHLY MEAN: 293. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 6870. FT ABOVE MSL
TERRAIN PARAMETER:  50. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


* COMPUTED VALUE
```


268

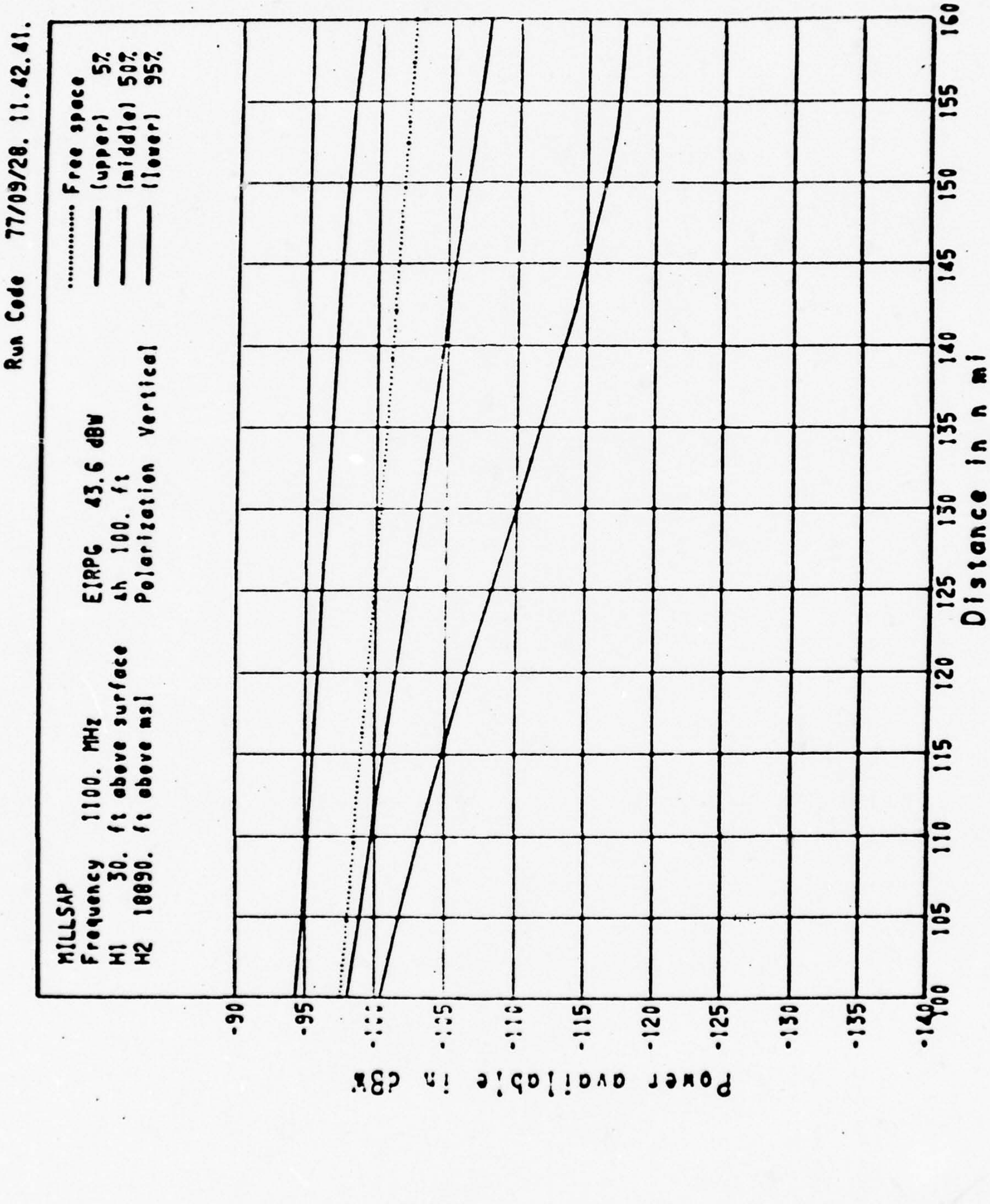


FIGURE I 29

269

```
PARAMETERS FOR ITS PROPAGATION MODEL  APR 77
        77/09/28.   11.42.41. FUN

     POWER AVAILABLE FOR MILLSAP
      REQUIRED OR FIXED
      -----------------
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  16690. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:     30.0 FT ABOVE SITE SURFACE
FREQUENCY: 1100. MHZ

      SPECIFICATION OPTIONAL
      ----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: VERTICAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:   800. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   43.6 DBW
FACILITY ANTENNA TYPE:  TACAN (RTA-2)
     POLARIZATION: VERTICAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:   4.50 N MI FROM FACILITY
     ELEVATION ANGLE:   -0/ 4/34 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT:  852. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4595. N MI*
     MINIMUM MONTHLY MEAN: 310. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE:  845. FT ABOVE MSL
TERRAIN PARAMETER: 100. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


* COMPUTED VALUE
```


(210)

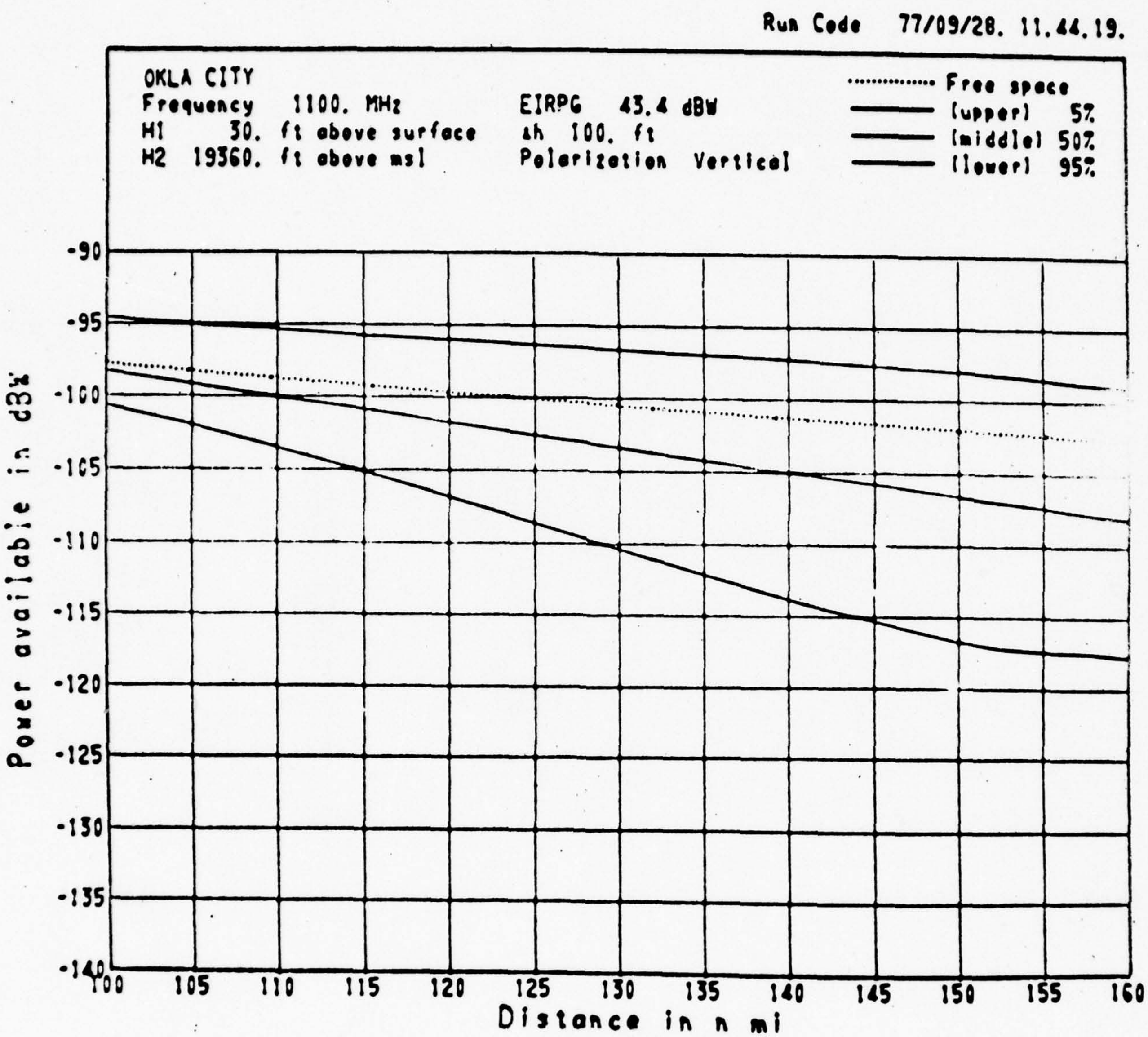

Run Code 77/09/28. 11.44.19.
OKLA CITY
Frequency 1100. MHz
H1 30. ft above surface
H2 19360. ft above msl
EIRPG 43.4 dBW
Δh 100. ft
Polarization Vertical
Free space
(upper) 5%
(middle) 50%
(lower) 95%
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
100
105
110
115
120
125
130
135
140
145
150
155
160
Power available in dBW
Distance in n mi

FIGURE I 30

PARAMETERS FOR ITS PROPAGATION MODEL APR 77
77/09/26. 11.44.19. RUN

POWER AVAILABLE FOR OKLA CITY
REQUIRED OR FIXED

```
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  19360. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:     30.0 FT ABOVE SITE SURFACE
FREQUENCY: 1100. MHZ
```

SPECIFICATION OPTIONAL

```
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: VERTICAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:  1350. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:    43.4 DBW
FACILITY ANTENNA TYPE:  TACAN (RTA-2)
     POLARIZATION: VERTICAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:    4.50 N MI FROM FACILITY
     ELEVATION ANGLE:   -0/ 6/29 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT: 1362. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4528. N MI*
     MINIMUM MONTHLY MEAN: 307. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 1390. FT ABOVE MSL
TERRAIN PARAMETER: 100. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED
```

* COMPUTED VALUE

272

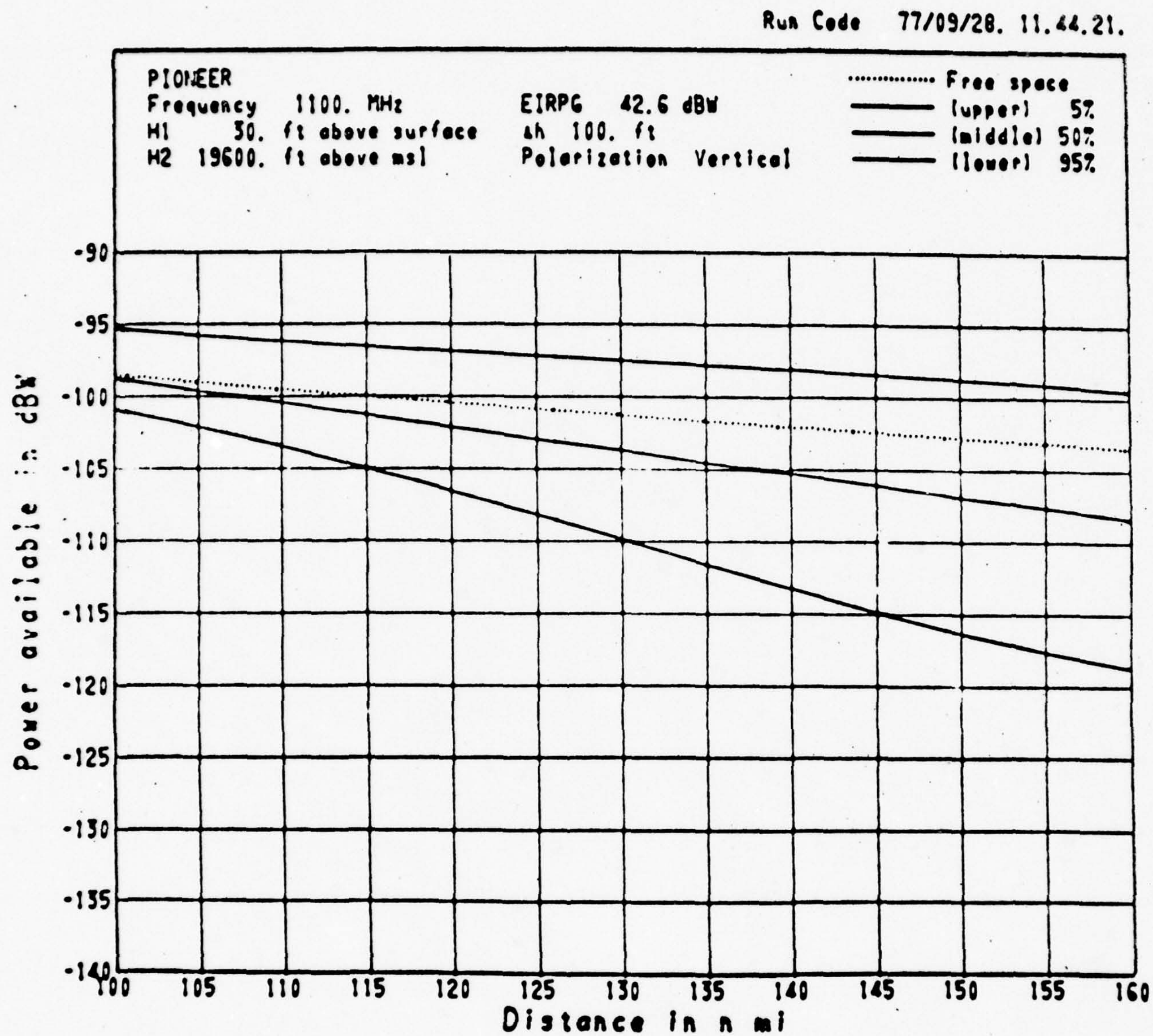


FIGURE I 31

273

PARAMETERS FOR ITS PROPAGATION MODEL APR 77
77/09/28. 11.44.21. RUN

POWER AVAILABLE FOR PIONEER
REQUIRED OR FIXED

```
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  19600. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:     30.0 FT ABOVE SITE SURFACE
FREQUENCY: 1150. MHZ
```

SPECIFICATION OPTIONAL

```
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
    POLARIZATION: VERTICAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:   920. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   +2.6 DBW
FACILITY ANTENNA TYPE:  TACAN (RTA-2)
    POLARIZATION: VERTICAL
    COUNTERPOISE DIAMETER:  52. FT
        HEIGHT:  12. FT ABOVE SITE SURFACE
        SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:  11.25 N MI FROM FACILITY
    ELEVATION ANGLE:   -0/ 9/19 DEG/MIN/SEC ABOVE HORIZONTAL*
    HEIGHT:  960. FT ABOVE MSL
REFRACTIVITY:
    EFFECTIVE EARTH RADIUS: 4561. N MI*
    MINIMUM MONTHLY MEAN: 307. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 1051. FT ABOVE MSL
TERRAIN PARAMETER: 100. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED
```

* COMPUTED VALUE

(274)

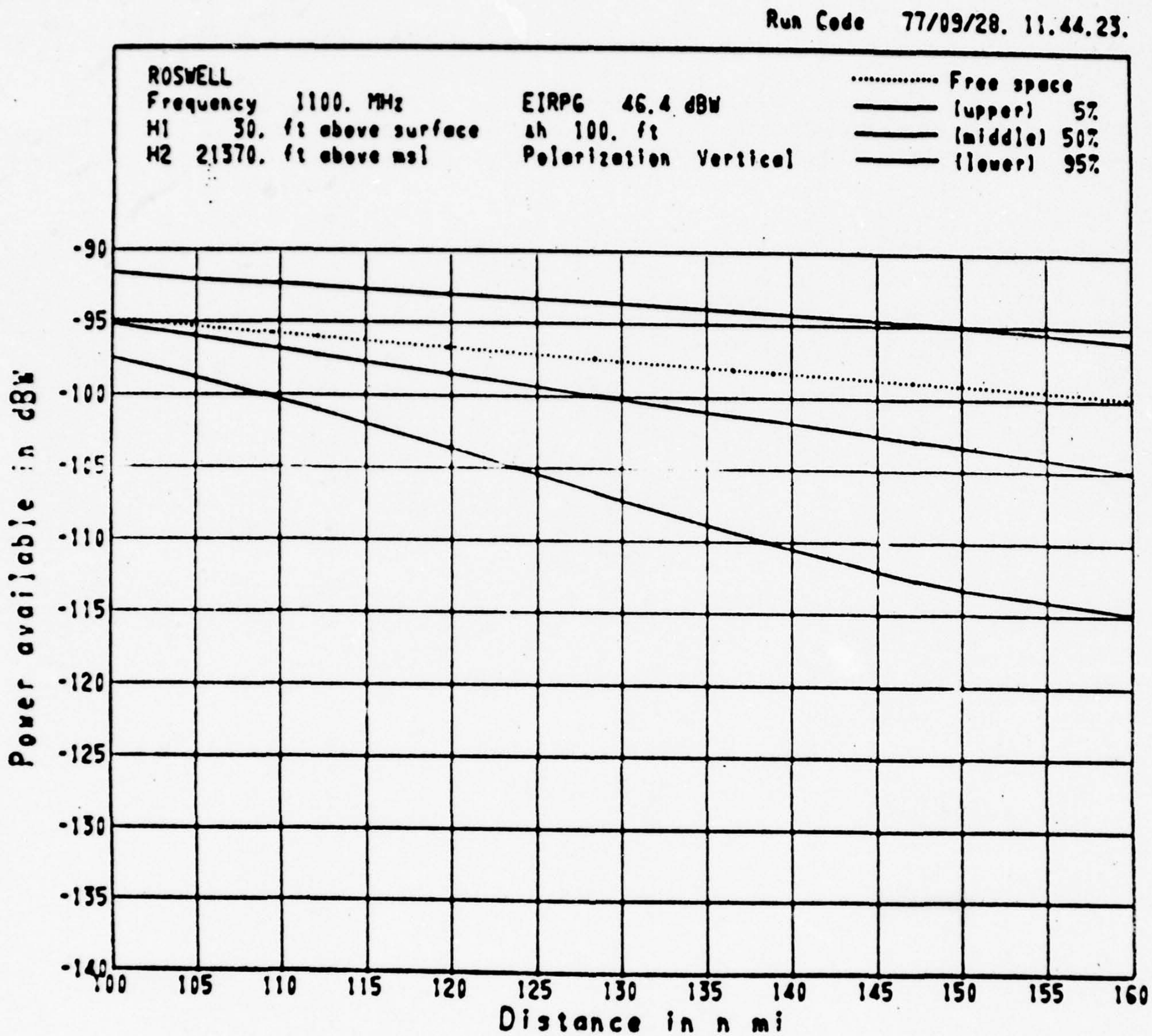


FIGURE I 32

275

PARAMETERS FOR ITS PROPAGATION MODEL APR 77
77/09/28. 11.44.23. RUN

POWER AVAILABLE FOR ROSWELL
REQUIRED OR FIXED

```
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  21370. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:     30.0 FT ABOVE SITE SURFACE
FREQUENCY: 1100. MHZ
```

SPECIFICATION OPTIONAL

```
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: VERTICAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:  3600. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   46.4 DBW
FACILITY ANTENNA TYPE:  TACAN (RTA-2)
     POLARIZATION: VERTICAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:  25.25 N MI FROM FACILITY
     ELEVATION ANGLE:   -0/12/21 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT: 3698. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4310. N MI*
     MINIMUM MONTHLY MEAN: 295. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 3770. FT ABOVE MSL
TERRAIN PARAMETER: 100. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED
```

* COMPUTED VALUE

276

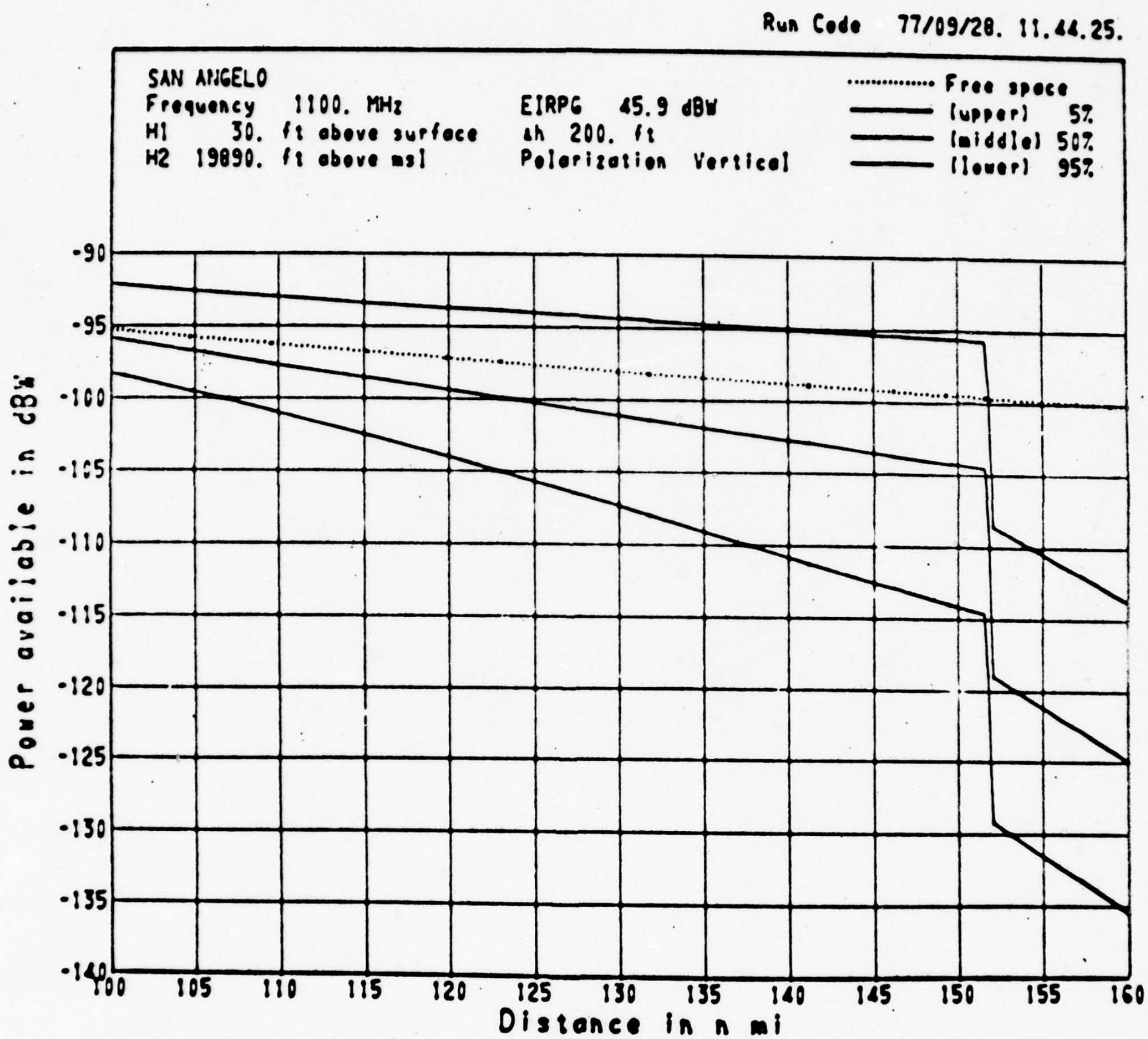


FIGURE I 33

277

```
              PARAMETERS FOR ITS PROPAGATION MODEL  APR 77
                    77/09/26.   11.44.25. RUN

                 POWER AVAILABLE FOR SAN ANGELO
                      REQUIRED OR FIXED
                      -----------------
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  19590. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:     30.0 FT ABOVE SITE SURFACE
FREQUENCY: 1100. MHZ

                 SPECIFICATION OPTIONAL
                 ----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: VERTICAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:  1900. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   45.9 DBW
FACILITY ANTENNA TYPE:  TACAN (RTA-2)
     POLARIZATION: VERTICAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:  14.25 N MI FROM FACILITY
     ELEVATION ANGLE:    0/ 7/ 1 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT: 2245. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4473. N MI*
     MINIMUM MONTHLY MEAN: 305. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 1900. FT ABOVE MSL
TERRAIN PARAMETER: 200. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


* COMPUTED VALUE
```


278

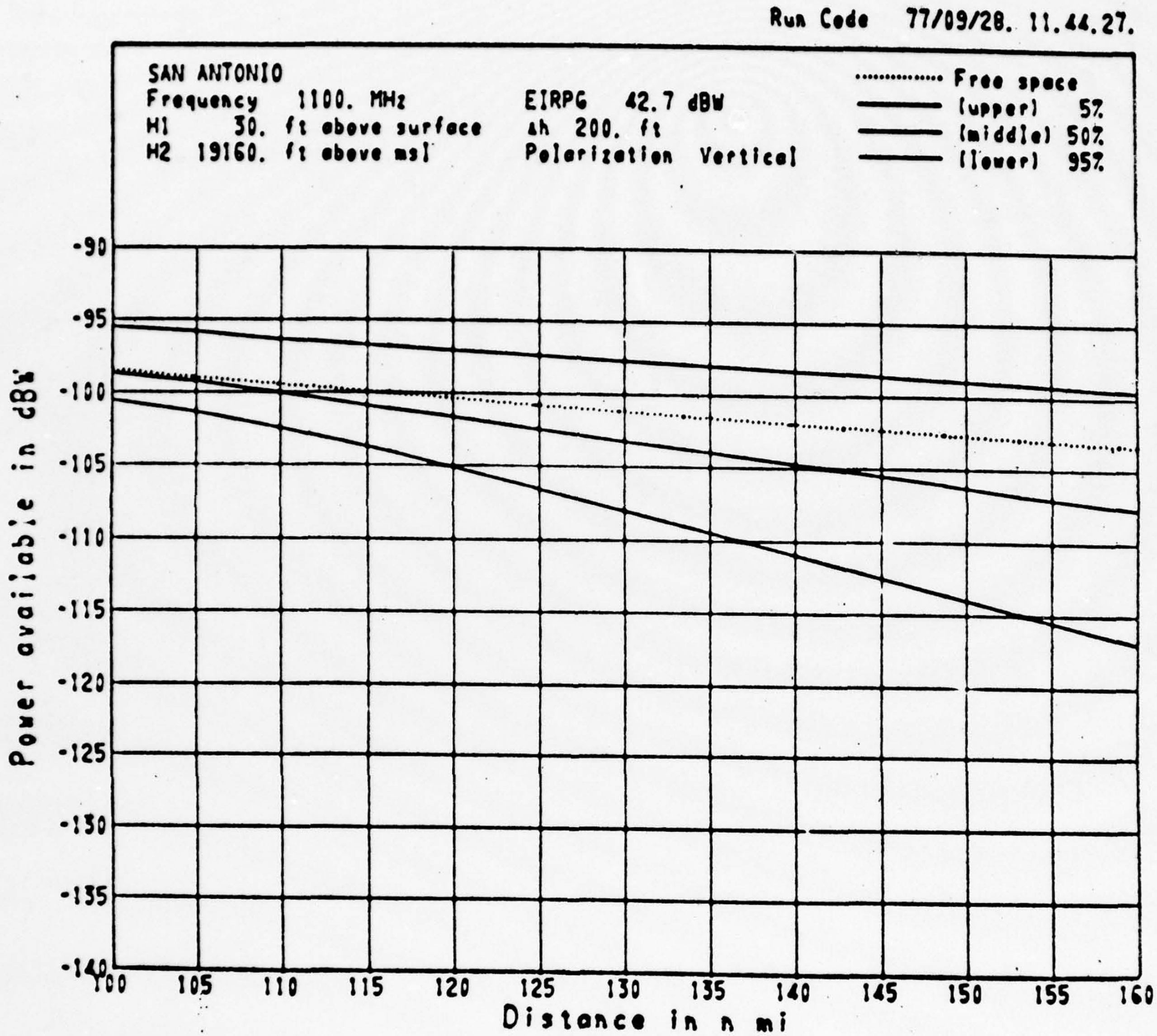


FIGURE I 34

279

PARAMETERS FOR ITS PROPAGATION MODEL APR 77
77/09/28. 11.44.27. RUN

POWER AVAILABLE FOR SAN ANTONIO
REQUIRED OR FIXED

```
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  19160. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:     30.0 FT ABOVE SITE SURFACE
FREQUENCY: 1100. MHZ
```

SPECIFICATION OPTIONAL

```
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: VERTICAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:   700. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   42.7 DBW
FACILITY ANTENNA TYPE:  TACAN (RTA-2)
     POLARIZATION: VERTICAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:  26.01 N MI FROM FACILITY
     ELEVATION ANGLE:   -0/18/ 7 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT:  788. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4665. N MI*
     MINIMUM MONTHLY MEAN: 317. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 1144. FT ABOVE MSL
TERRAIN PARAMETER: 200. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED
```

* COMPUTED VALUE

I 70

280

Run Code 77/09/28. 11.46.01.

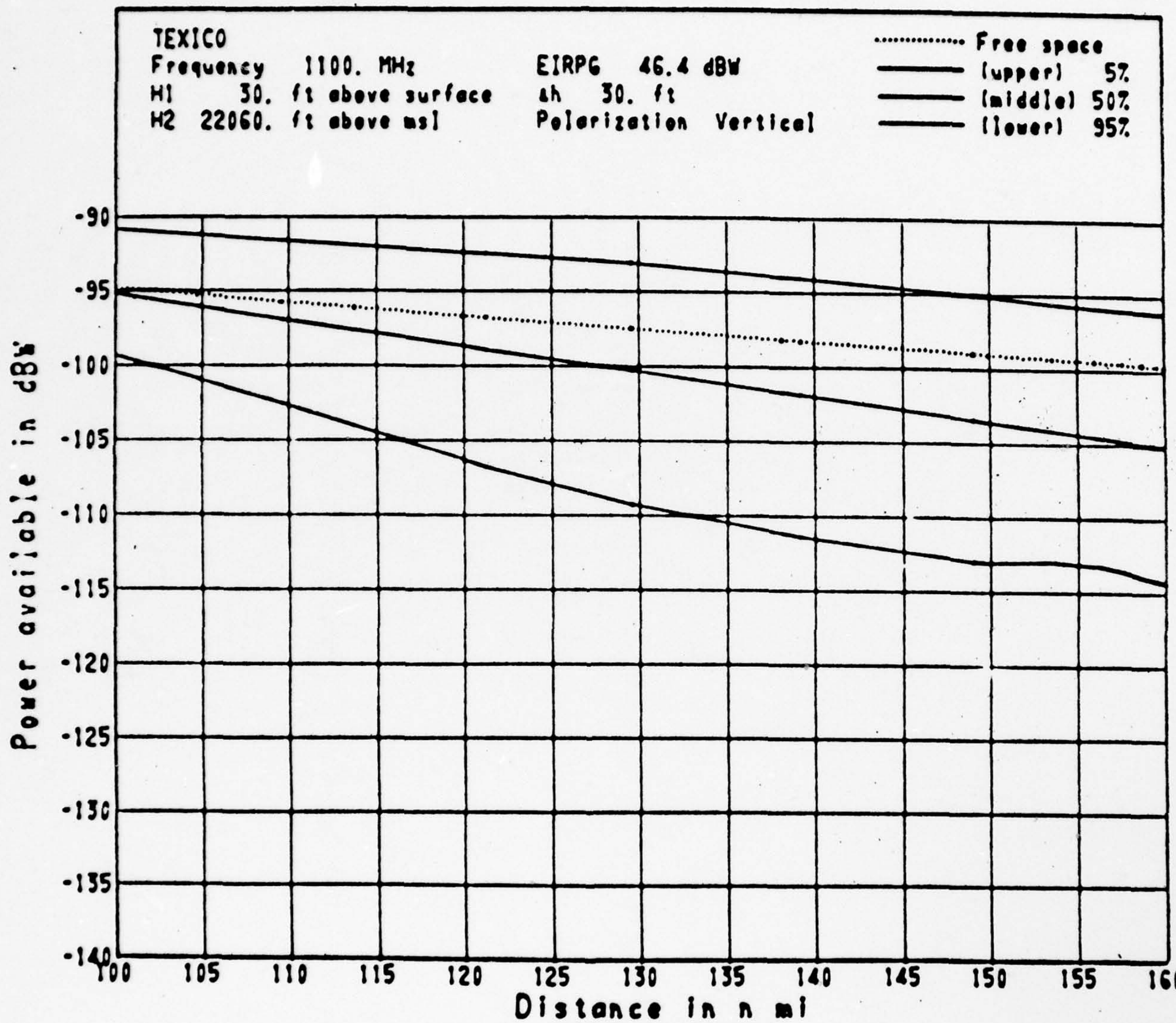


FIGURE I 35

281

77/09/28. 11.46.01.

PARAMETERS FOR ITS PROPAGATION MODEL APR 77

77/09/28. 11.46.01. RUN

POWER AVAILABLE FOR TEXICO

REQUIRED OR FIXED

AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE: 22050. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT: 30.0 FT ABOVE SITE SURFACE
FREQUENCY: 1100. MHZ

SPECIFICATION OPTIONAL

AIRCRAFT ANTENNA TYPE: ISOTROPIC
    POLARIZATION: VERTICAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL: 4030. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN: 46.4 DBW
FACILITY ANTENNA TYPE: TACAN (RTA-2)
    POLARIZATION: VERTICAL
    COUNTERPOISE DIAMETER: 52. FT
        HEIGHT: 12. FT ABOVE SITE SURFACE
        SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE: 8.75 N MI FROM FACILITY
    ELEVATION ANGLE: -0/ 4/17 DEG/MIN/SEC ABOVE HORIZONTAL*
    HEIGHT: 4100. FT ABOVE MSL
REFRACTIVITY:
    EFFECTIVE EARTH RADIUS: 4288. N MI*
    MINIMUM MONTHLY MEAN: 295. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING: CONTRIBUTES TO VARIABILITY
SURFACE TYPE: AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 4082. FT ABOVE MSL
TERRAIN PARAMETER: 30. FT
TIME AVAILABILITY: FOR INSTANTANEOUS LEVELS EXCEEDED

* COMPUTED VALUE

I 72

288

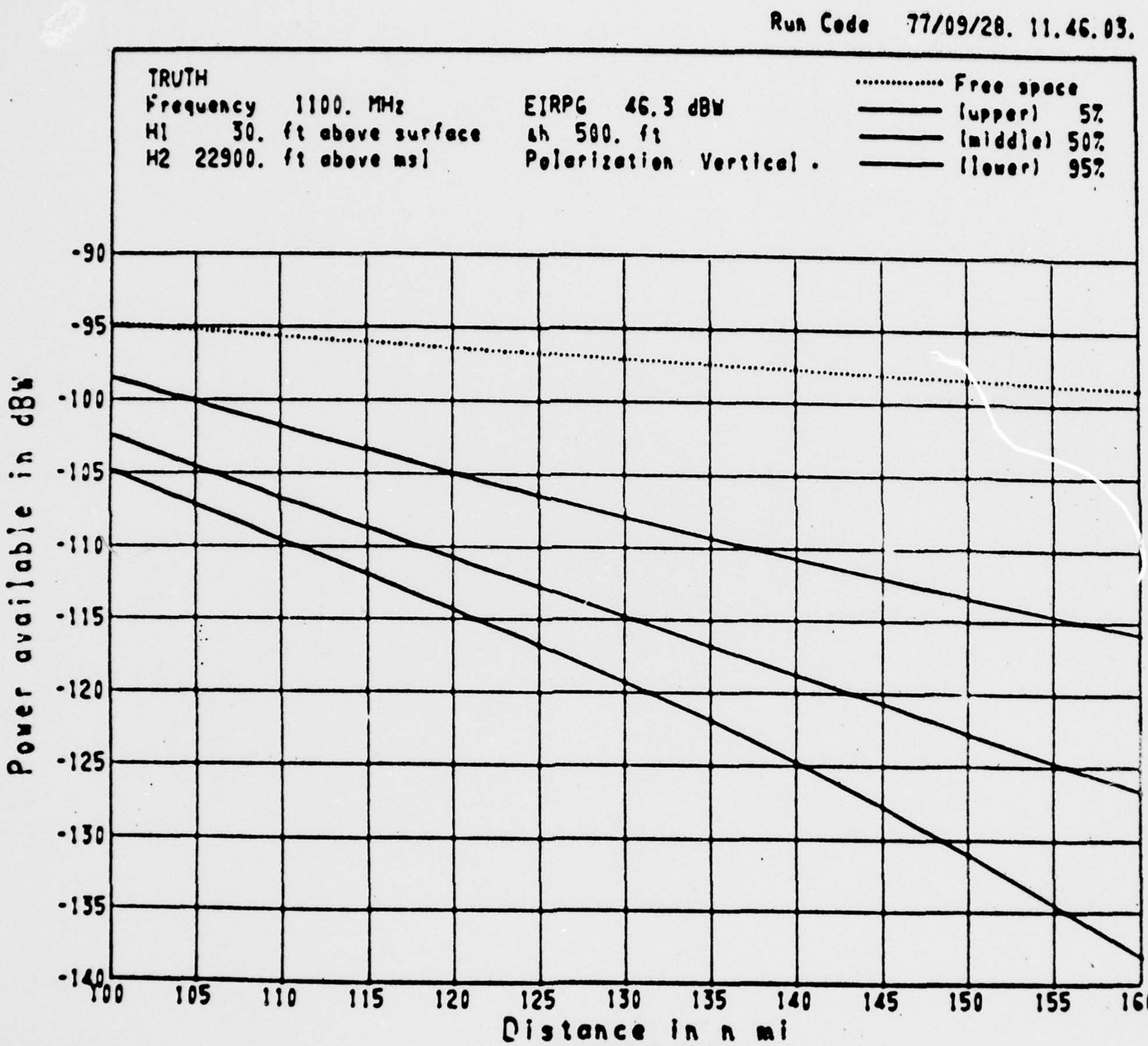


FIGURE I 36

283

PARAMETERS FOR ITS PROPAGATION MODEL APR 77
77/09/28. 11.46.03. RUN

POWER AVAILABLE FOR TRUTH
REQUIRED OR FIXED

```
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  22900. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:     30.0 FT ABOVE SITE SURFACE
FREQUENCY: 1100. MHZ

             SPECIFICATION OPTIONAL
             ----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: VERTICAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:  4800. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   46.3 DBW
FACILITY ANTENNA TYPE:  TACAN (RTA-2)
     POLARIZATION: VERTICAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:   9.50 N MI FROM FACILITY
     ELEVATION ANGLE:    1/ 5/46 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT: 6102. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4251. N MI*
     MINIMUM MONTHLY MEAN: 295. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 4903. FT ABOVE MSL
TERRAIN PARAMETER: 500. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED
```

* COMPUTED VALUE

I 74

284

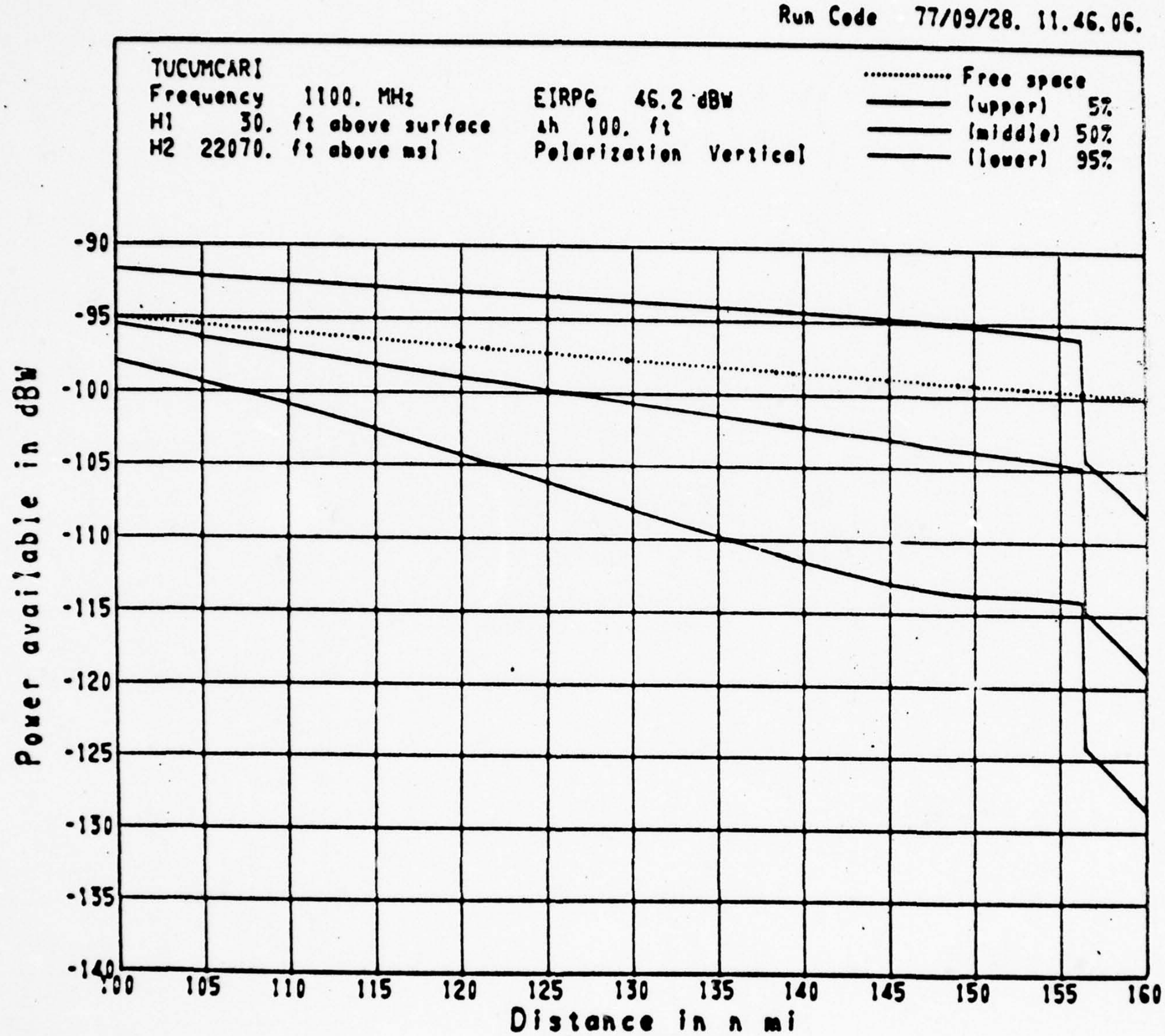


FIGURE I 37

285

```
                    PARAMETERS FOR ITS PROPAGATION MODEL  APR 77
                             77/09/28.    11.46.06. RUN

                         POWER AVAILABLE FOR TUCUMCARI
                           REQUIRED OR FIXED
                           -----------------
          AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  22070. FT ABOVE MSL
          FACILITY (OR LOWER) ANTENNA HEIGHT:     30.0 FT ABOVE SITE SURFACE
          FREQUENCY: 1100. MHZ

                        SPECIFICATION OPTIONAL
                        ----------------------
          AIRCRAFT ANTENNA TYPE:  ISOTROPIC
               POLARIZATION: VERTICAL
          EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:  4000. FT
          EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   46.2 DBW
          FACILITY ANTENNA TYPE:  TACAN (RTA-2)
               POLARIZATION: VERTICAL
               COUNTERPOISE DIAMETER:  52. FT
                    HEIGHT:  12. FT ABOVE SITE SURFACE
                    SURFACE: METALLIC
          HORIZON OBSTACLE DISTANCE:  12.50 N MI FROM FACILITY
               ELEVATION ANGLE:    0/ 1/16 DEG/MIN/SEC ABOVE HORIZONTAL*
               HEIGHT: 4201. FT ABOVE MSL
          REFRACTIVITY:
               EFFECTIVE EARTH RADIUS: 4279. N MI*
               MINIMUM MONTHLY MEAN: 293. N-UNITS AT SEA LEVEL
          SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
          SURFACE TYPE:  AVERAGE GROUND
          TERRAIN ELEVATION AT SITE: 4032. FT ABOVE MSL
          TERRAIN PARAMETER: 100. FT
          TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


          * COMPUTED VALUE
```

I 76

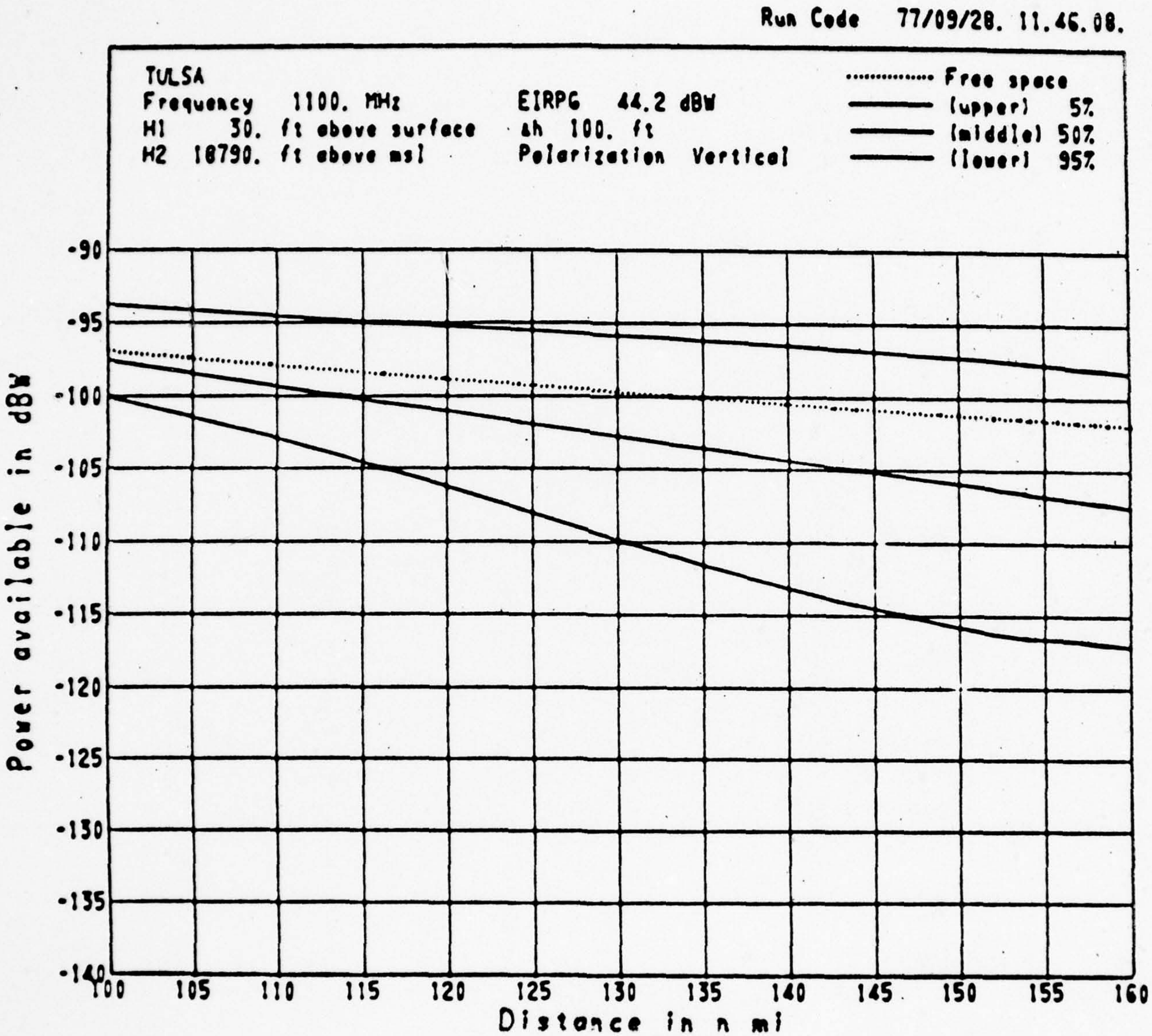


FIGURE I 38

287

PARAMETERS FOR ITS PROPAGATION MODEL APR 77
77/09/28. 11.46.08. RUN

POWER AVAILABLE FOR TULSA
REQUIRED OR FIXED

AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE: 13790. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT: 30.0 FT ABOVE SITE SURFACE
FREQUENCY: 1100. MHZ

SPECIFICATION OPTIONAL

AIRCRAFT ANTENNA TYPE: ISOTROPIC
POLARIZATION: VERTICAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL: 780. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN: 44.2 DBW
FACILITY ANTENNA TYPE: TACAN (RTA-2)
POLARIZATION: VERTICAL
COUNTERPOISE DIAMETER: 52. FT
HEIGHT: 12. FT ABOVE SITE SURFACE
SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE: 5.75 N MI FROM FACILITY
ELEVATION ANGLE: -0/ 4/12 DEG/MIN/SEC ABOVE HORIZONTAL*
HEIGHT: 791. FT ABOVE MSL
REFRACTIVITY:
EFFECTIVE EARTH RADIUS: 4597. N MI*
MINIMUM MONTHLY MEAN: 310. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING: CONTRIBUTES TO VARIABILITY
SURFACE TYPE: AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 782. FT ABOVE MSL
TERRAIN PARAMETER: 100. FT
TIME AVAILABILITY: FOR INSTANTANEOUS LEVELS EXCEEDED

* COMPUTED VALUE

288

Run Code 77/09/28. 11.46.12.

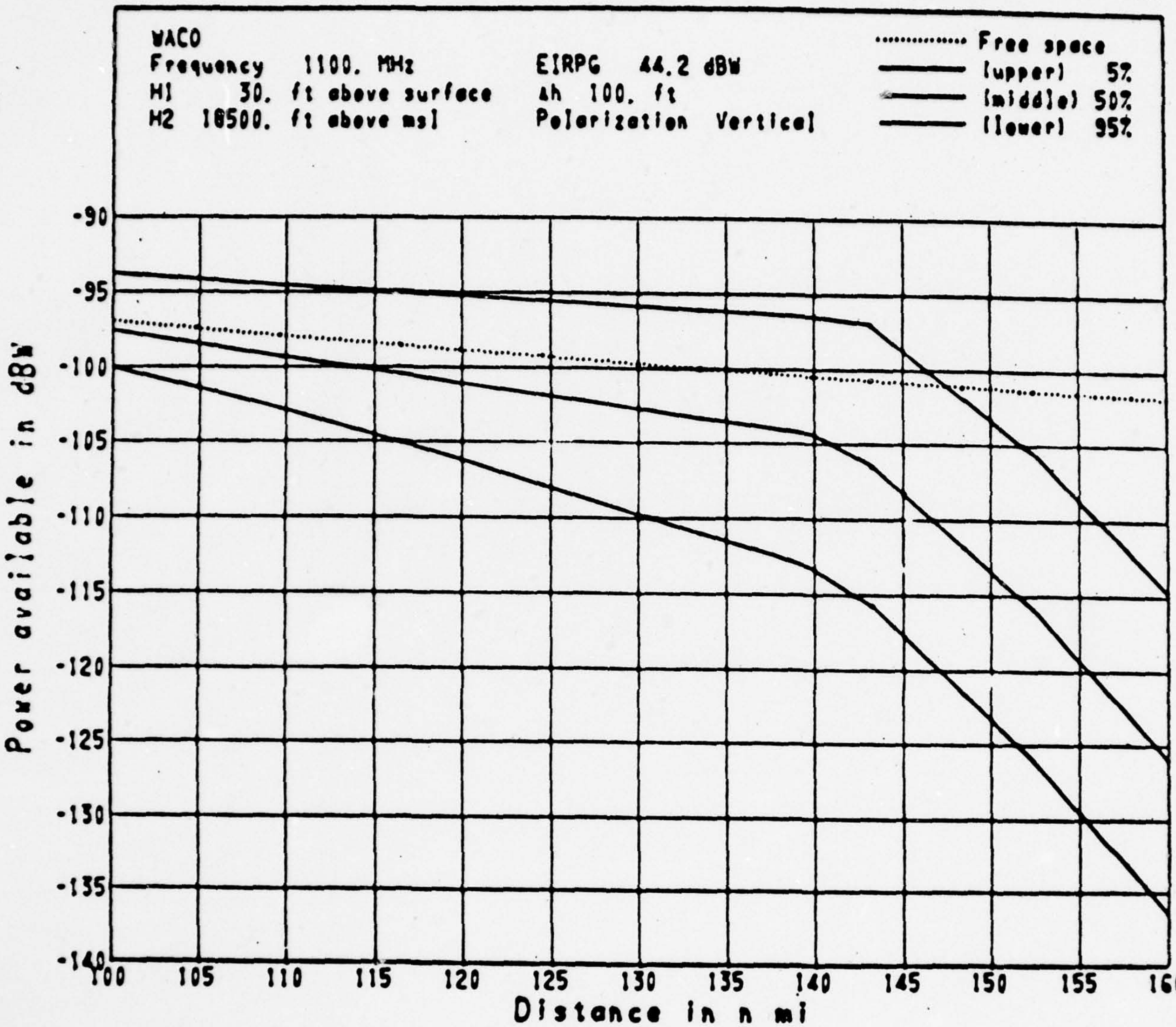


FIGURE I 39

289

```
              PARAMETERS FOR ITS PROPAGATION MODEL  APR 77
                         77/09/28.    11.46.12. RUN

                     POWER AVAILABLE FOR WACO
                     REQUIRED OR FIXED
                     -----------------
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  18500. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:     30.0 FT ABOVE SITE SURFACE
FREQUENCY: 1130. MHZ

                 SPECIFICATION OPTIONAL
                 ----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: VERTICAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:   500. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   44.2 DBW
FACILITY ANTENNA TYPE:  TACAN (RTA-2)
     POLARIZATION: HORIZONTAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:   1.75 N MI FROM FACILITY
     ELEVATION ANGLE:    0/ 8/43 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT:  559. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4639. N MI*
     MINIMUM MONTHLY MEAN: 312. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE:  500. FT ABOVE MSL
TERRAIN PARAMETER: 100. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


* COMPUTED VALUE
```

290

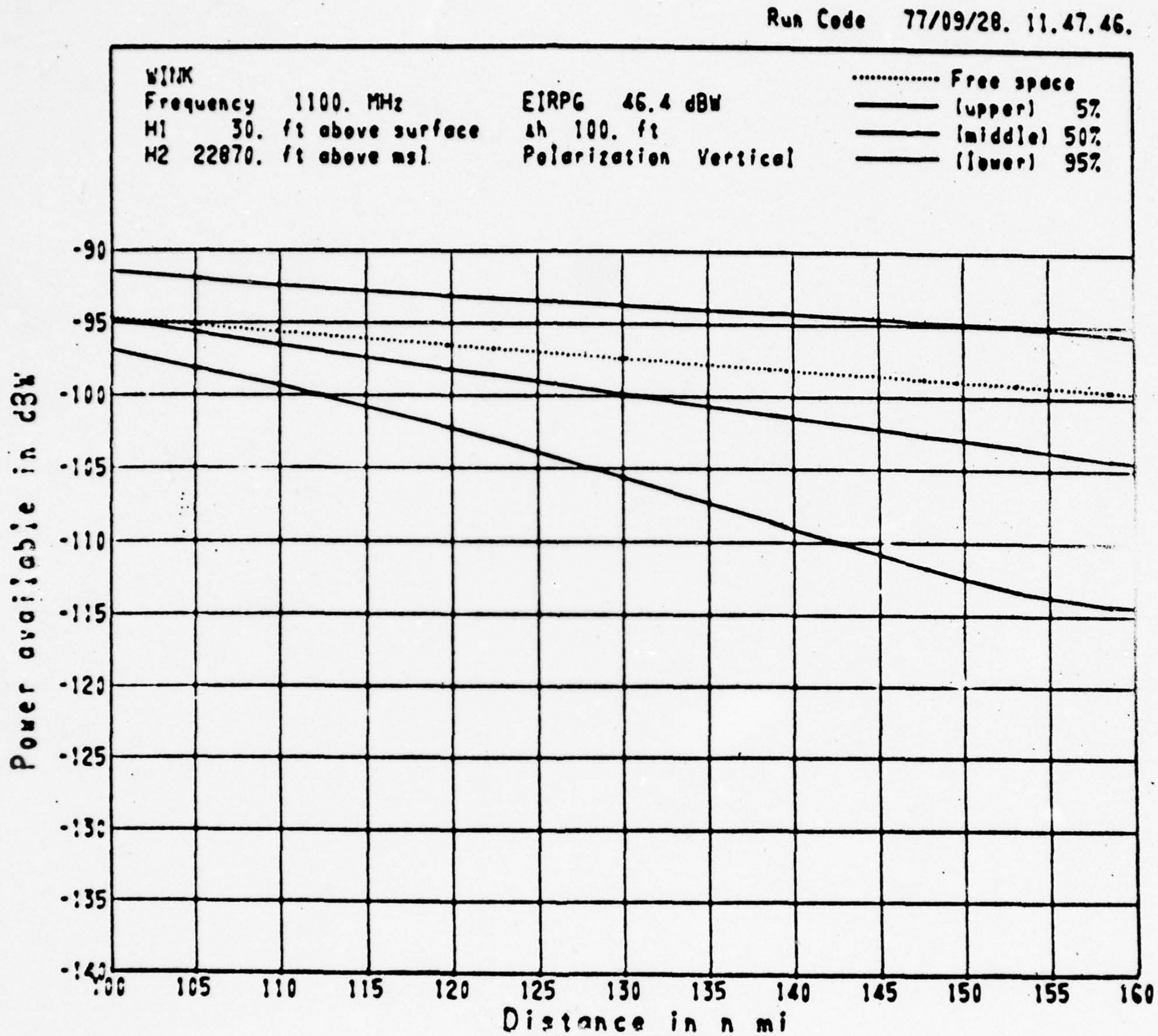

Run Code 77/09/28. 11.47.46.
WINK
Frequency 1100. MHz
H1 30. ft above surface
H2 22870. ft above msl
EIRPG 46.4 dBW
Δh 100. ft
Polarization Vertical
Free space
(upper) 5%
(middle) 50%
(lower) 95%
Power available in dBW
Distance in n mi

FIGURE I 40

```
                    PARAMETERS FOR ITS PROPAGATION MODEL  APR 77
                          77/09/28.    11.47.46. RUN

                    POWER AVAILABLE FOR WINK
                    REQUIRED OR FIXED
                    -----------------
AIRCRAFT (OR HIGHER) ANTENNA ALTITUDE:  22670. FT ABOVE MSL
FACILITY (OR LOWER) ANTENNA HEIGHT:     30.0 FT ABOVE SITE SURFACE
FREQUENCY: 1100. MHZ

                 SPECIFICATION OPTIONAL
                 ----------------------
AIRCRAFT ANTENNA TYPE:  ISOTROPIC
     POLARIZATION: VERTICAL
EFFECTIVE REFLECTION SURFACE ELEVATION ABOVE MSL:  2819. FT
EIRP PLUS RECEIVING ANTENNA MAIN BEAM GAIN:   46.4 DBW
FACILITY ANTENNA TYPE:  TACAN (RTA-2)
     POLARIZATION: VERTICAL
     COUNTERPOISE DIAMETER:  52. FT
          HEIGHT:  12. FT ABOVE SITE SURFACE
          SURFACE: METALLIC
HORIZON OBSTACLE DISTANCE:   6.50 N MI FROM FACILITY
     ELEVATION ANGLE:   -0/ 7/36 DEG/MIN/SEC ABOVE HORIZONTAL*
     HEIGHT: 2819. FT ABOVE MSL
REFRACTIVITY:
     EFFECTIVE EARTH RADIUS: 4351. N MI*
     MINIMUM MONTHLY MEAN: 295. N-UNITS AT SEA LEVEL
SURFACE REFLECTION LOBING:  CONTRIBUTES TO VARIABILITY
SURFACE TYPE:  AVERAGE GROUND
TERRAIN ELEVATION AT SITE: 2847. FT ABOVE MSL
TERRAIN PARAMETER: 100. FT
TIME AVAILABILITY:  FOR INSTANTANEOUS LEVELS EXCEEDED


* COMPUTED VALUE
```

292

END